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MICRO-LEPIDOPTERA.
(COLEOPHORA, OR TENT-MAKERS.)

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(*With a Coloured Plate.*)

If these summer months are favourable for the study of leaf-mining caterpillars, and the abundance and variety of their hieroglyphics arrest our eye in every walk, and give new specimens for our cabinet, not less so are these months, from June to October, for collection of the curious and interesting Coleophorum. The moths themselves are not nearly so beautiful as the *Nepticulæ* and *Lithocolletis;* the wings are lanceolate, unicoloured, or striped with silken-gray under-wings, and they sit with bodies closely pressed to the substance on which they rest, with antennæ thrown forward, much like the *Tischeriæ*.

The larvæ of this genus are the objects of our present research and interest, because their habits manifest an instinct and design which open for us a delightful field of observation. They feed upon the parenchyma of leaves, and mine irregular blotches as they feed; but with the cuticle, or leaf itself, or husk of seed, it fashions a tent, under which it walks about, and within which it retires when the time of its pupa rest has come, and the resurrection into *perfect life* is at hand.

As a general rule for the guidance of young naturalists, when we find a blotched or mined leaf with a round hole, as truly outlined as if drilled with a centre-bit, we may be sure that a Coleophora has been feeding there, and this little hole was the entrance into his pasture-ground, covered closely by its tent, whilst the owner penetrated into the soft, juicy parenchyma, and stretched away, as far as its body would reach, on all sides, careful only to keep its anal hooks at the tent door to secure a retreat on the least alarm.

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I have at this moment about twenty specimens of the Coleophora (*Limosipennella*) feeding on a branch of elm, in water, on my table, and one is under the binocular mining for its daily food; another I turned out of its pretty case that it might make a new one for my edification, and the verification of a former statement. Whilst it is uneasily walking about, wriggling its unhoused tail, and apparently measuring those serrated edges of the elm-leaf, I will give some particulars of the Coleophora as a genus of the Micro-Lepidoptera.

There are forty-one British species described by Stainton,* and many of them have been mentioned and figured by various naturalists, Reaumur, Curtis, Haworth, Duponchel, and our own Westwood, under the synonymes of Porrectaria, Ornix, Gracillaria, Astyages. At present they bear the very appropriate name of Coleophora, from *Kŏleon* (a sheath), *Phoros* from *Phero* (to bear).

The larva of a Coleophora has sixteen legs; the prolegs are very undeveloped; the six true legs are pointed and scaly as those of large caterpillars. They have invariably dark spots on the anterior and anal segment, and a horny plate on the second segment, which I imagine to be used by the insect to smooth the asperities of the leaf, as it is observed to turn about and rub its head over every part of its case previous to lining it with silk. There is also a plate on the anal segment to protect that part from the friction to which it is exposed by the protrusion of the anal segment in voiding its excrement.

These tiny caterpillars, scarcely noticed by the unassisted eye, are wonderful in their instinct, as the *Lithocolletis* are marvellous in their beauty. Here is a mere speck, a little brown, naked worm, busy on the leaf before me; nothing can be more insignificant in appearance, or more unworthy of minute attention; hardly does the careless eye perceive it, and yet how the detail of its structure reveals the mind of its Great Creator; the same wisdom planning, and the same goodness adapting each organ for the tiny workman that has given to man his more perfect body.

Look closely at the larva itself before we describe its proceedings. Externally we observe a small black head, with six simple eyes in a circle on each side, a pair of sharp-toothed jaws, four little palps or feelers, and a spinnaret immediately under the jaws; six true legs and ten membranous appendages, thirteen joints or segments, and on each segment a spiracle dilating and contracting as the larva breathes and moves. At the anal segment there is a protuberance, armed with hooks, which it uses as a claw to attach itself to the leaf whilst making its case, and afterwards as a grappling-iron to retain possession

* Vol. iv. and v. of *Natural History of the Tineina*, by Stainton and Zeller.

of its tenement. So far, externally, we may pause to admire the adaptation of its body for its present phase of life; but, if taking advantage of the long and patient labours of Lyonnet, Dufour, Swammerdam, and other distinguished naturalists, we pass from the outward form to the internal mechanism of this minute creature, taking its various functions of respiration, circulation, nutrition, secretion, with sensation, and muscular action, one by one, into quiet, thoughtful consideration, far greater will be our appreciation and admiration of the little Coleophora before us.

Its *sensation* depends upon its nervous system, and that consists of a chief ganglion, or little brain, followed by twelve other little ganglia united by nervous cords, and giving out branches in pairs more numerous even than those of our own human body, for Lyonnet counted ninety of these branches in a caterpillar, and *we* have but seventy-eight.

Its *respiration* who can conceive? unless the eye has seen, under high microscopic power, the wonderful complexity and delicate tracery of the tracheal vessels which envelope and permeate the whole of the internal organs attached to the external spiracle, aerating and life-giving.

The *circulation* is provided for by the throbbing, no, not throbbing, but pulsating heart, which beats so strongly and evenly, sending the white, cold blood in steady current to and fro from chamber to chamber of the dorsal vessel, in each of which it receives exhilarating oxygen from the network of trachea surrounding it. The life of a larva is calm and unimpassioned, the instinct of self-preservation more developed than the instinct of reproduction; the calm pulsation of the silkworm is very different from the fluttering pulses of the silkworm *moth*.

Its *nutrition*. We may not give time to that, with all its elaborate arrangement of pharynx, œsophagus, crop, gizzard, biliary vessels, etc., etc., etc. Let us rather consider its *muscular* action, for it is very remarkable in our little tent-maker.

If any one has seen the preparation of the Cossus by Mr. Robertson, in the Oxford Museum, an illustration of Lyonnet's researches, proving the existence of 4,061 muscles in that caterpillar, 228 being attached to the head, 1,647 to the body, and 2,186 to the intestines—remembering that we have no reason whatever for denying the same number of muscular bands to the smallest larva, and that the Coleophora in particular has need of every kind of muscle in the fashioning and bearing about its tent, a feeling of positive awe steals over the mind. Every kind of muscle! Yes—levators, depressors, flexors, extensors, abductors, adductors, supinators, and pro-

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nators. We need but watch the persistent action of those busy jaws to be very sure that its *abductors* and *adductors* are in perfection; whilst to twist about its spinnaret and weave the tapestry of its chamber, supinators and pronators must be in full play, as well as the ceaseless constrictor muscles, opening and closing the spiracles, and giving such varied movements to the segments of the abdomen. Would the dorsal vessel pulsate without that arrangement of muscular fibre, by which the systole and diastole is maintained? and would the peristaltic motion, so necessary to digestion, go on without that exquisite network of innumerable muscular threads, which twine along, and across, and around every internal organ? No; all this mystery of life goes on planned, directed, and sustained beneath the tegument of this microscopic worm.

Now what is the little larva about? I have placed it under the microscope; he has at length entered the leaf, and eaten more than the length and breadth of its body. I turned it out of its case at two P.M. It wandered restlessly until four P.M., then fixed and opened its circular door, slowly going forward, until on my return at ten P.M. it had advanced into perfect shelter. The next morning a large blotch was eaten, but I was in time to sit beside the elm branch and watch the making of the tent.

It had fixed near the edge of the leaf, and was carefully eating out the parenchyma of each serrature, leaving the edges untouched, as it thereby saved a seam in the tent, yet emptying each tooth to make it light and less brittle. When all was clear, the larva measured a gentle curve a little larger than its body, and began to draw the cuticle together on the opposite side to the serratures—tacking it loosely at first, and biting the membrane between the fibres, sewing it more neatly then, and careful not to cut the supporting braces formed by the nerves of the leaf. Then it rubbed the interior of the case with its head, as if to smooth it, and presently began to darken it with a web of fine silk, rendering further operations invisible, only I perceived that one end was left open for the ejection of its excrement, and that the fibres were cut mysteriously away, when the tent by powerful muscular action was raised from the leaf, and the Coleophora marched off to refresh itself in a new excavation.

Yet that was another point on which to rest and ponder. What was it eating, and how much did it eat?

What store of delicate and varied food lies in the cells of any leaf; sugar and starch and chlorophyll, oils and gums and raphides; ay, and in some plants, like the common nettle, beautiful crystals suspended from the cell wall, or floating about; sweetmeats and candies for the little gourmand—no

wonder it eats so much; in twelve hours it ate the weight of its own body; as if a man should in the same time demolish thirty four-pound loaves of bread!

But lest some matter-of-fact reader should consider this formation of a case at the edge of a leaf as a mere routine of instinct, let us see how Reaumur tested the resources of one of the same *Limosipennella*.

He did as I have done, turned one out to make a new case, but when the excavation was complete he cut off the teeth of the leaf. The two membranes flew apart, and the little larva seemed to be surprised and troubled; after a little hesitation apparently it saw the remedy, turned itself about, and threw a few threads from side to side, pulled them close and joined the rent. Then, as if considering that a like misfortune might happen again, before proceeding in the work of mining necessary for a full-sized case, it darkened the interior of the mine with a regular silken tube, which it left to continue and mine in a curve directly down the leaf and across the fibres. Now and then it returned to the tube, and lengthened and strengthened that; yet with strange forethought the case was not woven throughout—not at all; one side was merely tacked together and spaces left by which the larva could put out its head and cut the leaf between the fibres which now supported the case (fig. 8). Yet somehow perceiving that from the cutting away of the edge the natural curve was destroyed, the larva actually changed the aperture from one end to the opposite, in order to obtain the proper and convenient shape. At last, after two days' hard work, the tent was finished, and the thoughtful, patient little architect went on its way towards the development and perfection of its being.

The *Coleophora Vitella*, whose case is figured (2), may be found as early as April, having begun its case from the leaf of *Vaccinium vitis idæa* (cranberry) in the autumn, and up to the end of the month the case is being continually enlarged with pieces of the mined leaf, giving it a wrinkled appearance, and being paler near the mouth as fresh bits are added, and the case becomes pistol-shaped. The moth comes out at the end of June, and is abundant near Manchester.

Coleophora laricella (Fig. 4 a).—Very small is this pretty little tentmaker, feeding on the tenderest shoots of the larch in early spring time. It was hatched in the autumn, and mining a slender leaf it cut it off and hoisted it as a tent for its shelter and defence, remaining asleep in it all the winter, and with the first warmth of April, and with the cuckoo's note, awakening to feed on the under side of the fresh green leaves. The mine is very transparent, and the proceedings of the caterpillar easily observed. The moth is all one colour, a light brown

with silky grey under-wings. This is widely distributed at Guildford, Manchester, York, Scotland.

Coleophora juncicolella.—Lying on the heathy heights of Dover, watching the blue bright channel sea dancing the fleet of little fishing boats, and heaving the great ships to and fro, nestling for shelter in the tufts of Erica and Calluna, I idly wondered what those withered tips might be that topped the living stem. From the wide expanse of ocean and troubled thoughts within, the tent of the little Heath Coleophora turned eye and mind to ponder on the cunning work of this small architect. Who teaches it to pluck the little leaves, and count them seven or nine, nor more nor less, and weave them into this pretty case (fig. 5)? Some are withered and reddish-brown or yellow, and the lower ones are green, so making a parti-coloured tent, from which by and by a small grey-winged moth shall rise, and flit into the heath-bells for honey-drops and repose.

Coleophora Muripennella. (Fig. 6 A.)—Here is another surprise, picking the brown heads of Luzula in June, the seed vessels are all alive. Look closely; take a pocket lens; a little black head peeps out of a seed, and we find the larva has banqueted on the substance within, ensconced itself in the husk, and marched off to empty another seed, and so feed away until the long pupa sleep comes on, and April with its primroses and anemones brings also young Luzulas, whereon the delicately-striped brown moth will lay its eggs and finish the task of its life.

They are found, these curious cases, near London, Lewes, Worthing, York, Scarborough, Scotland, and the moth is abundant from April to June.

Coleophora Curricepennella. (Fig. 7.)—This pretty striped moth is more abundant abroad than in England, yet is found near London and Wimbledon in May and June, producing a larva which weaves a case entirely of silk, quite black, and with four projections, diminishing towards the mouth, and one row forming a right angle with another row. It eats the leaf so delicately that the parenchyma is removed, and the perfect network of fine veins is left unbroken.

Coleophora lineola. (Fig. 9.)—It is worth while having a good hunt for this tentmaker on the under side of *Ballota nigra* (black horehound), or *Lamium purpurea* (purple dead nettle), and if you see some whity-brown glassy-looking blotches in September on these leaves, look *under* the leaf, you will most likely find quite a little company of them perambulating a single leaf. By all means place one of these tents under the binocular; the silvery hairs upon the dark cuticle, and the fresh bit probably added to the first part of the tent, will delight the observer. And perhaps another is still more beautiful, the tent-maker

found on *Viper's buglos*, with its jointed hairs and thin crystal bulbs glistening like jewels on the dark green case. This is the *Coleophora Onosmella*, and found on chalky districts in the south of England, at Sandown, in the Isle of Wight, plentiful; and also at Dover.

Coleophora discordella. (Fig. 10.)—On grassy banks where the *Lotus corniculatus* grows, here we shall find this ingenious little workman very busy. Piece after piece he adds to his tent. Some brown, some yellowish, or nearly white, and it curves over like a reversed cornucopia. This larva feeds in August, and a silvery-striped pretty moth comes forth in June, for, like most of these case-bearers, it has a long larva-life of nearly nine months, hybernating in the cold winter, and recommencing active life in the spring.

Space allowed not of more drawings, but these will suffice to arouse attention, and I will add a list of plants on which to look for various species of tent-makers. Very likely this will lead not only to much personal pleasure, but to real advance in science, for the known species doubtless fall far short of the unknown, and the roads and lanes of England have many a footmark of Divine wisdom and goodness that may be found upon the track of our tiny *Coleophoræ*.

On the Rushes . . . . . *C. cæspititiella.*
On Silene inflata . . . . . *C. inflata.*
On Furze buds . . . . . *C. albicosta.*
On Knapweed. . . . . *C. conspicuella.*
On Stellaria Holastea . . . *C. solitariella.*
On the Sallow. . . . . *C. viminetella.*
On Wormwood . . . . . *C. ditella.*
On Cistus . . . . . *C. ochrea.*

REFERENCES TO PLATE.—Fig. 1. Coleophora chalcogrammella. 1 A. Larva-tent feeding on Cerastium arvense. 2. Tent of Coleophora Vitella. 3. Larva of Coleophora. 4. Shoots of larch with larva of C. laricella. 4 A. The tent of C. laricella magnified. 5. Tent of C. juncicolella on heath. 5 A. The same magnified. 6. Tent of Coleophora Muripennella. 6 A. The same magnified. 7. Coleophora Curricepennella. 7 A. The tent of the same magnified. 8. Elm leaf with tents of Coleophora Limosipennella. 8 A. A tent just cut from the leaf. 8 B. The larva walking off with its tent. 9. The tent of Coleophora lineola. 10. The tent of Coleophora discordella.

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A VISIT TO LLANDUDNO.

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A GLANCE at Professor Ramsay's excellent geological map of England and Wales will show a conspicuous and irregular mass of limestone, belonging to the carboniferous series, considerably to the left of the estuary of the Dee, and to the right of the Menai Straits. This is the Great Orme's Head, a magnificent promontory, protected through the hardness of its material from being washed away by the long-continued beating of the waves, which have hollowed out a huge gap in that portion of the British coast. Properly speaking the "Head" is the termination of the mass, the rest being locally known as the "Llandudno Mountain," beneath whose shade a smartly-built watering-place has rapidly sprung up, much frequented by Liverpool families, and catching an occasional Londoner to vary the scene. The Great Orme's Head is the attractive feature to the ordinary visitor. All round its sea-beat wall a pathway has been cut, beginning a few feet above the high-tide level, winding from east to west, ascending many hundred feet, and presenting at every turn a grand view of distant coasts, and wide-spread waters, studded with many a sail. Looking eastward, the eye roams beyond the Little Orme's Head, the other barrier of the little bay, catches the flat washy land of the two remarkable estuaries of the Mersey and the Dee; and rests, if the weather permits, on the shores of the West Riding of York. As the path winds, huge irregular masses of rock overhang the way; far down below seethe the white surge and foam, and presently, in a grassy slope, is seen the little church of St. Tudno, who must have been of a very ascetic way of thinking to have resorted to so wild a region, and one so remote from the society of his fellow-men. The path again ascends, and twists; Lancashire and Yorkshire are lost, and Anglesey comes more and more into view, with its outpost of Puffin's Island, in which multitudes of sea birds are said to breed. As the headland is rounded, the splendid cone of Penmaen-Mawr rises across the estuary of the Conway river; and when a southern view is obtained, the mountains of Snowdonia mingle their summits with the clouds, and close the scene. Sun-set pours its red and yellow light gloriously over these varied outlines, and those who differ from Hood in the assertion that

> "A man that's fond precociously of stirring,
> Must be a spoon,"

speak with equal favour of the magnificence of the sun-rise.

Continuing the circumbendibus brings the pedestrian with his back to the sea and his face towards the mouldering towers of Conway Castle, once more to Llandudno, after a walk of more than five miles, and very near the spot at which his peregrinations commenced.

This is one way of enjoying the Llandudno mountain. Another is to climb up a steep road, and arrive at a miniature plateau some 600 or 700 feet above the sea level. In this journey, one or two copper mines, apparently not over productive, are passed; and at nearly the highest spot is a low building, maintained by the Liverpool Corporation as a look-out house, from whence ships destined for their city can be first descried, and the news telegraphed to the busy merchants on 'Change. Three telescopes, let into copper panes of the bow-window by a ball and socket joint, enable the observer to see in any direction without exposure to the weather; the telegraph machinery is under his thumb, scores of posts bear its wires down the hill, and then a few vibrations of the obliging needle tell the news on which the profit or loss of the shippers may depend. This *was* the state of things last September, but a few hundred feet lower, and less influenced by sea-fog, a lighthouse was rising among the rocks, and to that locality the look-out and telegraph business was about to be transferred.

At the time of my visit one part of the little plateau was like a formal garden of nature's own contriving, but preserving with its regularity that wildness which exerts a lasting charm. Hundreds of small, round, and flattened furze bushes—floral puddings, as they might be called—blazed with yellow bloom, and in the centre of each mass gleamed the rich purple of the heather-bell. In less fertile spots the hard whitened rock lay in flat strips of varying breadth, and in the clefts flourished the dark, stiff foliage of the rue-leaved spleenwort, sometimes accompanied by flowering plants. Occasionally a little hollow made a water pool, with leathery green leaves growing in it, and forming an abode for numbers of the common rotifer, which seemed as happy as at lower levels and in larger ponds.

A marine zoologist living at Llandudno can do a good deal, as the magnificent aquarium formed by Mr. Drabble, and described in a former number, will amply prove, and as may be seen from the subjoined list which he has enabled me to give :*—

It is not, however, a very good place for the casual visitor,

ZOOPHYTES.

* Caryne pusilla.	Tabularia larynx.
„ sessilis.	Halecium halecinum.
Tubularia indivisa.	Sertularia polyzonias.

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as the most accessible beach—that of the Conway estuary—is rather poor in specimens, and the other one—opposite the Parade and below the Baths—does not yield much, except at low spring tides. On such occasions you must watch the time, rush down at the right moment, search in nooks and crannies with impetuous haste, chisel and hammer at the rocks with speculative rapidity, never mind if the waves turn round upon you before your labours are concluded, provided that they leave a possibility of retreat, and you will then return duly splashed and wetted, with bottles and a basket full of treasures which will keep your hands and microscope employed for many a day.

Many parts of the Devonshire and Dorsetshire coasts are much more practicable for ladies, who ought to be made upon mermaid principles, with their lower halves specially adapted to the briny abode of the tritons and the nymphs, in order to enjoy the slopping and puddling manœuvres which the Llandudno collector has to go through. The process is, however, well worth the trouble, as my first haul will show. Here was a reddish-yellow gristly and slimy lump, ugly enough before being placed in a basin of water, at his ease. Then out came the elegant bunch of gill plumes from his back, the pretty tentacles from his head, and the fine sea-slug, the *Doris tuber-*

Sertularia fallax.
" abietina.
" filicula.
" operculata.
" argentea.
Sertulariacupressina.
" pumila.
" rugosa.
Antennularia antennina.
Plumularia falcata.
" cristata.
" setacea.
Laomedea geniculata.
" gelatinosa.
Campanularia dumosa.
" volubilis.
Alcyonium digitatum.

ANEMONES.

Sagartia viduata.
" troglodytes.
" aurora.
" venusta.
" miniata.
" coccinea.
Actinoloba dianthus.
Actinia mesembryanthemum.
Bunodes crassicornis.
Edwarsia carnea.
Peachia hastata.
etc., etc.

POLYZOA.

Tubulipora.
Crisia eburnea.
" denticulata.
Crisidia cornuta.
Cellularia.
Scrupocellaria.
Canda reptans.
Gemellaria loricata.
Bicellaria ciliata.
Bugula avicularia.
Flustra foliacea.
Membranipora membranacea.
Membranipora pilosa.
Lepralia (various).
Cellipora.
Alcyonidium gelatinosum.
" hirsutum.
Cycloum papillosum.
Valkeria.
Bowerbankia.
Pedicellina Belgica.
" echinata.
etc., etc.

culata, rejoiced the eye. He is no rarity, but, like most of his family, beautiful when displayed, and great is the wonder of those who have no acquaintance with this kind of creature to find its gills, or water-lungs, converted into decorations as fine as any ostrich plume. Two other items look even more unpromising at first sight than our friend the slug; they are dirty leathery tubes, caught up from little hollows at the bottom of the rocks. They, or rather their inmates, are now happy in a washhand basin, which, for a time, will do as well for them as Llandudno Bay. From each tube comes forth an exquisitely painted thing, something between a fan and a flower. Here again are specimens of ornamental gills. Through each plume the fluids to be aerated take their course. While all is quiet, the living fan, or flower, expands its rays; but if danger approaches, in goes the wondrous apparatus, and only the dingy tube remains in view. Mr. Gosse has described how these worms (*Sabella*)* make their tubes, and they are so much at their ease in Mr. Drabble's aquarium, that they will replace the plumes which some habit of their nature, or temporary disease, causes them to shed.

It is a very common characteristic of the sea-beauties to be mere lumps of ugliness when not at home. The two instances given will illustrate this fact, but here are morsels of dirty gristle, yellowish and white, more or less cleft into lobes and finger-like projections. Nothing could seem further removed from the ideal than such unpleasant prosy dabs. They were torn off the sides of rocks, which only low tides uncover, hid among the hanging tresses of the Bladder-weed (*Fucus vesiculosus*), and only discoverable by active search. These, too, the friendly basin holds, and after they have had time to get over the flurry incidental to their capture, from every dent and pore out come hundreds of polyps, clear as crystal, each enjoying its individual life, and also its portion of the social or collective life of the entire mass, which is named "Mermaid's Glove," "Dead Men's Fingers," or *Alcyonia digitata*.

Small lumps of honey-combed rock, struck off with hammer and chisel, are among the captures of the day. They were selected because certain little red spots, visible till disturbed, suggested a probability of acquiring the not very common and very pretty anemone, the *Edwardsia carnea*, which Mr. Gosse figures and describes in his admirable work. When they think all is safe, they come out of their little caves; when alarmed, they retreat, and no one unacquainted with their habits would suspect their existence in the deserted-looking rock.

Other classes of creatures have helped to fill the bottles and the basket, such as polyzoa, and polyps very different

* See INTELLECTUAL OBSERVER, March, 1863, p. 77.

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from the Alcyonia in their mode of fashioning their homes. The Llandudno beach yields a good supply of Bugula, a branching polyzoon like a tiny shrub, having its groups of cells so arranged as to produce a pattern something like what would result from putting a series of funnels one in the other, with their spouts pressed close to the sides of the mouths, in which they were immersed. This is not an *exact* description, but near enough to help a beginner in recognizing this curious thing. These Bugulæ are good specimens of the polyzoa to exhibit the bird's-head processes, which occur in many genera, and still puzzle naturalists to explain their use. They are attached to the corners of cells; often look, as in this case, like vultures' heads, and nod and snap their beaks with pertinacious efforts, that sometimes catch a creature that may be swimming by. Mr. Gosse considers their function is to hold such objects, in order that in their decay they may attract other creatures which the ciliary currents, kept up by the tentacles of the polyzoon, may draw into its ravenous mouth. The specimens of Bugula which I collected at Llandudno in September, did not, in any case in which I watched them, open and snap their vulture heads, which either nodded like so many mandarins, or remained perfectly still. I do not know whether the animals were sickly, or whether the activity of their heads varies with the season or temperature to which they are exposed. The heads are pretty objects under a quarter-inch or fifth objective, and much more brittle than the material of which the cells are composed, so much so that, when dried, a slight pressure of the live-box crushes them like glass.

I cannot describe each species, or genus, obtained between the tide-marks, but may mention that *Crisia, Valkeria, Lepralia, Membranipora, Sertularia, Laomedea,* etc., etc., were amongst the lot; but having to make a selection from my notes, I will first say a few words on the microscopic examination of such an object as *Membranipora pilosa,* a very common polyp covering sea-weeds with a crust, and often following their shape; and then make, for the nonce, the odd-looking and oddly-behaved *Pedicellaria echinata* do duty for the tribe Polyzoa, to which he belongs. Turning to Johnstone's *Zoophytes* we find the Membranipora described as follows—"Polypodium encrusting, membrane calcareous, spreading irregularly, formed of a single layer of alternating approximated cells; cells oval, horizontal, membraneous, the aperture patulous, with a hard calcareous rim." *M. pilosa* is described as having "aperture of the cell with one long hair and several spinous denticles." Now this and many similar objects are too small to be seen properly with a very low power; and if a higher one, say fifty or sixty linear, is employed, certain parts are quite out of the focus when

others are in. The only way to proceed with such things is to get a good general notion with a pocket lens, or three-inch glass first, and then take the higher power, remembering that no *one* view can possibly give a correct idea of the whole. The long spines of the *M. pilosa*, for example, may be optically reduced to a little boss at their base, through all the rest being out of focus and not seen. The observer must gradually focus up and down, carrying in his eye what the glass at each movement fails to reveal, and if this is carefully done a good many times, a right conception of the object will be obtained.

Returning from this digression to the *Pedicellina echinata*, I will now introduce the reader to a curious polyzoon not uncommon, but interesting from its departure from the more usual patterns of the class to which he belongs.

The *Pedicellinæ* may be rudely compared to the short flexible sticks with knobbed ends, called "life-preservers," and the present species (*echinata*) has spines down the aforesaid stick. Most of the polyzoa* have long tentacles, which are always stiffer than those of the polyps, and furnished with cilia that are readily seen. Were we only acquainted with the long tentacled kinds, we might imagine that short tentacles would not suffice to do enough food-catching to keep one alive; and this may be the case in situations where their prey is scarce; but there are places in which polyps can live whose tentacles, as in the Corynæ, are reduced to mere knobs, and in which a correspondingly stunted polyzoon gets on very well. I do not know enough to assert that this food question settles the short-tentacled difficulty, but the explanation is probable, and we can easily conceive that long-armed polyps and polyzoa might flourish where shorter armed species would starve.

Some of my *Pedicellinæ* pursed up their mouths by keeping their tentacles in, others expanded themselves, as shown in the sketch made by my wife, while others were content with an intermediate state. They were the most lively I ever caught, being in constant motion, thumping about in all directions, sometimes coming down right and left with hammer-like blows at nothing, at others executing a spiral manœuvre, and giving a corkscrew wriggle to their stout flexible stems, which were ornamented with occasional spines. They were far from nervous, and did not mind coming into contact with other bodies, and must have been troublesome neighbours to the more timid and quietly disposed inhabitants of the various cells in whose vicinity they lived and banged about.

There was frequent motion in their tentacles, and for a moment one set were fully spread out; but after watching them

* See my paper, INTELLECTUAL OBSERVER, Vol. II., p. 271, on the "Statoblasts of a Plumatella," for some general remarks on these creatures.

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for hours I could trace no co-ordination between the movements of the stems and those of the tentacles. They were not directed to a common object of catching food, and if the *Pedicellinæ*, like other polyzoa, possess a "colonial nervous system," they have no brain capable of directing their whole mechanism to an intelligently devised end.

PEDICELLINA ECHINATA.
(*c*, *c*, *c*, Ciliary Action.)

The whole class of polyzoa possess, so far as I have observed them, very restless stomachs, and in the *Pedicellina* the particles of food were not suffered to be a moment at rest, but were spun round and round by the constant action of the cilia with which the digestive tube is lined. In the pursed-up individual to the left of the engraving, the dark mass appeared to consist of the remains of a feast, ready to be turned

out of doors, while the lighter mass below it, still under process of digestion, performed the circumtwistatory movement imparted to a leg of mutton by a roasting-jack. In some other Polyzoa, as the Plumatella, the food is tossed backwards and forwards up and down the digestive tube.

In the sketch some of the stalks are without heads, or more properly *bodies*, and on this subject Johnston observes* that, "like the hydroid Tubularinæ, the life of the body is of shorter duration than that of the stalks, the former fading or falling off, when a new one is reproduced in its place." He likewise cites Professor Reid to the following effect:—"A few days before this (the falling off of the body) takes place, the tentacula are permanently bent inwards, and the membrane surrounding their lower parts remains contracted, so as to completely, or nearly completely, cover the upper surface of the body, presenting, in fact, the appearance which the animal temporarily assumes when disturbed. The body then becomes more opaque, and at last falls off. When this has taken place the stalk retains its property of alternately contracting and relaxing its different surfaces at intervals, upon which its movements depend. After the lapse of a few days the top of the stalk enlarges, and a minute head presents itself, in which the different parts of the body are developed." This is an interesting fact when it is considered that the body contains the mouth, stomach, and other important organs, and also the nervous ganglion which performs the functions of a restricted brain. It is an instance of the power of the colonial life which animates every member of a polyzoan group in addition to what we may term his individual life, and is evidently a process of the same character as that which forms the original offshoots from the parent stem. Inside the mouth cavity, and below the tentacles, ciliary action may be observed, and favourable specimens display the circular band of muscles running round the margin of the cup, whose function is to pull it together.

Professor Allman discovered an arrangement of the tentacular disk which approaches these creatures to the Hippocrepian Polyzoa, that is to those in which the tentacles are arranged not in a circular, but in a horse-shoe group. Three species may be found on our coasts: the *P. echinata*, just described, with spines on its stalks; the *P. gracilis*, which has stalks smooth, thin, and long; and the *P. Belgica*, with smooth stalks inflated about the middle. The stalks rise from a creeping shoot, and the creatures are commonly found parasitic on corallines and sea-weeds, between tide marks, but especially near low-water mark. The species mentioned above vary in

* *A History of British Zoophytes*, by George Johnston, M.D., LL.D. Second edition, p. 384.

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the number of their tentacles. *P. Belgica* has twelve tentacles, *gracilis* and *echinata* about twenty. Some of my specimens of *P. echinata* had eighteen.

In Mr. Gosse's *Devonshire Coast* he mentions an instance of a colony of *P. Belgica* growing as parasites upon the tail of a Syrinx, a wandering animal of vermicular shape belonging to the Echinodermata, and, as might have been supposed, an unfit site on which to found a colony of Polyzoa.

Many other objects of interest rewarded a little pains taken at Llandudno, but I will only allude to one of them, the *Perophora*, just for the sake of mentioning a rapid change in transparency which a short period produced in this interesting mollusk, without its showing any other symptom of bad health. One afternoon Mr. Drabble brought in a group of *Perophora* to show the beautiful ciliary action of its internal gills, which he had been admiring under his own microscope shortly before. On trying it with mine our success was very moderate, and no mode of illumination would make it sufficiently clear. For experiment sake he fetched his own instrument, but the result was the same, the explanation being that the outer skin of the animal had contracted, or undergone some other change, and its translucency was impaired.

Some of my readers may find themselves at Llandudno, and the preceding remarks may help them to collect objects; but most that I have said will apply to other sea-side places, and none can be found in which nothing of interest for the microscopic naturalist exists. My Welsh trip left many pleasing recollections, but there is a peculiar charm in marine zoology, and while the outlines of hills and mountains often rise in my view, I see with equal clearness of remembrance the motions of the *Pedicellinæ*, or the brilliant lightning sparks emitted by irritated colonies of *Sertularia* newly dredged from their homes at the bottom of the bay.

ON CAMPHOR PULSATIONS.

BY CHARLES TOMLINSON,

Lecturer on Physical Science, King's College School, London.

[We have much pleasure in publishing the following interesting letter from Mr. Tomlinson, who is quite right in stating that the article in our May number to which he refers did not detail all the precautions necessary for the successful performance of the more delicate experiments. Our object was rather to call attention to his very good and accessible book than to supply a substitute for it. We are glad to hear that the further investigation of the "Storm Glass" occupies his attention.]

In the Intellectual Observer for May last you notice briefly a few experiments from my small volume recently published, entitled *Experimental Essays;* so briefly, indeed, that should your readers endeavour to repeat them they may fail of success through not taking all the precautions which I have detailed in my book. For example, the experiment for exhibiting the camphor currents is one that requires great care, and several favourable conditions to make it succeed. In the *first* place, the vessel must be quite clean; *secondly*, the water must be quite clean,—it need not be distilled; *thirdly*, the camphor must be cut into the form of a stick, or a three or four-sided prism, and be mounted in forceps, as shown in the engravings on page 38 of my book; *fourthly*, the surface of the water must be very faintly dusted with lycopodium powder, which is best done by tying a small quantity of it up in a muslin bag, and gently shaking it over the surface; *fifthly*, the day must be fine and dry. If all these conditions be observed the experiment will succeed. As soon as the camphor is lowered into the water a powerful repulsion of the lycopodium powder takes place, occasioned by the formation of a camphor film, from which lines of solution will stream out, and, being reflected symmetrically by the side of the vessel, will throw the lycopodium powder into pairs of revolving wheels, and the action will continue with greater or less vigour so long as the camphor continues to be immersed, provided the air be sufficiently dry to get rid of the film by evaporation. In the course of some hours, depending on the size of the camphor stick, the camphor will be cut across at the surface of the water (as in Venturi's experiment, described in my first essay), and the lower portion thus becoming detached will rotate about the surface of the water and destroy the symmetry of the lycopodium wheels. On removing this piece, and lowering the stick so as to dip just below the surface of the water, the currents will set in afresh, and a new incision be made in the camphor. In this way I have kept up these currents for fifty or sixty hours.

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The vessel selected for the above experiment was a conical foot glass, four inches in diameter at the mouth. I have lately had occasion to show the experiment in a very shallow vessel with a flat bottom, and have obtained some additional results, which may be interesting to your readers. Two vessels were employed, one a glass saucer, used for holding a glass flower pot; it is five inches in diameter, and slightly raised at the bottom. The other a flat dessert dish of uncut glass, 6½ inches in diameter. The phenomena are best seen in glass vessels, but a dinner or dessert plate will answer the purpose. The glass saucer was made quite clean, two ounces of water were poured into it, and a stick of camphor, 1½ inch long, and about ¼ inch square, with a square base, mounted in forceps, was brought down so as to touch the bottom in the centre of the slightly convex swelling. No sooner does the camphor touch the water than a series of vibrations sets in, agitating the whole surface of the water with rapid pulsations, so rapid, indeed, that it is scarcely possible to count them. I have, however, made out as many as 260 per minute.* In this small quantity of water solution takes place rapidly, and the water becomes saturated; hence the pulsations gradually diminish to 60 or 80 beats per minute, when solution and evaporation may be considered as pretty well balancing each other. I have even known the pulsations to sink down to 8 or 10 per minute, and to subside altogether when the air became damp from wet weather. On changing the water the pulsations will set in again, but not with the maximum rapidity, unless in a dry air.

There is one condition connected with the complete success of this experiment which I was some time in discovering. It is this. The stick of camphor must be cut in the direction of the grain or cleavage of the camphor, but not across it or obliquely to it. On holding a piece of camphor up to the light it will soon be seen in what direction the cut is to be made, and when the piece has been nicely trimmed and mounted in its forceps, and brought down so as to touch the bottom of the vessel, the action appears to be this:—The water rises by capillary attraction some way up the camphor, and detaches a portion of its substance, which is then spread out in the form of a film over the surface of the water by the attraction of adhesion, and is there disposed of by solution and evaporation, after the manner of essential oils. As the film is being detached, it repels the water from the camphor, and produces a depression of surface all round the stick; the water recovers itself by a bound, capillarity again comes into play, another film is detached, and matters proceed as before; the result being a series

* These rapid pulsations are best seen on the larger surface of the water in the dessert dish.

of pulsations or waves, which rise up so that their crest may be one, two, or three-tenths of an inch above the general surface of the water. These variations in height are marked by a series of curved grooves or ripple lines on the sides of the camphor, which gradually changes its dull translucent appearance for a bright transparent one, showing that the water has penetrated it. In the meantime an incision is made in the camphor, which goes on increasing as successive films are detached, until at last the stick is cut through, and the submerged piece commences a series of gyrations on its own account.

If lycopodium powder be faintly dusted over the surface, the camphor currents and pulsations may on a fine day be seen together. If two sticks of camphor be lowered into the same surface of water, the interference of the currents will be shown by the motions of the powder.

As in the case of small fragments of camphor rotating rapidly on the surface of water, the rotations are stopped if the water be touched with a fatty oil, so these pulsations are immediately arrested if the water be touched with a drop of any substance which spreads into a film, and arrests evaporation. The point of a pin dipped into olive oil and brought into contact with the water, at once arrested the lycopodium currents, a second contact stopped the pulsations. So also, if a body be added to the water that satisfies its adhesion, or, in other words, stops the solution, the pulsations are arrested. Thus a drop of oil of camphor will stop the pulsation by depriving the water of the power of dissolving camphor; a drop of olive oil will stop the pulsations by preventing the water from evaporating; but a drop of oil of bitter almonds, which speedily evaporates, will allow the pulsations to go on again very soon after it has been added. Turpentine, oil of cajeput, kreosote, etc., stop the pulsations; but ether, alcohol, benzole, naphtha, bisulphide of carbon, caustic potash, and sal-ammoniac, allow them to go on freely. A bit of sponge tied to the end of a glass rod, if dipped in ether and held near the camphor, will hold up the wave of water against the camphor for some time. A drop of benzole does not stop the pulsations, but it makes them less rapid. The pulsations will go on in a solution of caustic potash and in one of sal-ammoniac, and I have no doubt that the action of acids, etc., on rotating camphor as described in my first "Experimental Essay," will have a similar action on the camphor pulsations.

In your notice of my book you say that I do "not seem by any means to have exhausted the curious subject of the Storm Glass." I had reserved this subject for a separate essay, a copy of which I hope to have the pleasure of sending you shortly.

With respect to the motion of camphor towards the light

you do not seem to have apprehended me fully, or I may not have expressed myself clearly. My theory is that light has nothing to do with the deposit of camphor, of vapours, or of crystals of saline solutions on the most illuminated side of the glass vessels that contain them, but that such deposits are formed by condensation on the coldest side of the vessel, which may or may not be the most illuminated side. If a number of bottles containing a little camphor, naphthaline, iodine, water, turpentine, etc., be placed in the window, the deposits will be formed generally on the side nearest the light, because that side is generally the coldest; but if the sun be shining on the window, the side nearest the light will be the hottest, and the deposit will go to the back of the bottle, or to the coldest side. If the bottle be equally heated in every part, and equally cooled, no deposit will be formed except at the bottom of the vessel, unless the cooling be sufficiently rapid and great to condense the elastic vapour as it subsides. We shall then have a deposit equally all round the glass, and this is the more likely to happen with a thin one, because glass being a bad conductor of heat, a thick narrow glass is not so likely to cool unequally; it does not, in fact, present a cold side and a warmer side, unless under favourable circumstances. For instance, a thick barometer tube containing a charge of camphor was left in one corner of a warm room, it was afterwards exposed to the cold of winter, and when next examined it was found to have a deposit equally all round. It will, of course, be understood that under all ordinary circumstances a bottle containing camphor, etc., is filled with the vapour of that substance at all ordinary temperatures. A certain depression of temperature is required to cause a deposit, as in the case of dew, and unless the temperature be sufficiently depressed there will be no deposit. In vacuum, the camphor deposit may be formed in a few minutes, as in Dr. Draper's experiments, and it was to get rid of the cumbersome machinery of air-pump, and air-pump receivers, that I made use of the more sensitive crude camphor, which forms a good deposit if a little of it be placed at the bottom of an ordinary corked vial. So sensitive is this vapour of crude camphor that it will revive marks, and small impurities in the bottle, the presence of which was not suspected. The minute invisible filaments left by the duster used in wiping out the bottle, become visible in a few minutes after the bottle has received its charge of crude camphor, and exposed in the window in consequence of becoming coated with that substance condensed upon them.

King's College, London,
15*th June*, 1863.

NOTES ON THE MOLE.

BY THE REV. J. G. WOOD, M.A., F.L.S.

A FEW days ago, a deputation of young friends brought me a fine specimen of the common mole, which they had captured in Belvedere Park. The creature had evidently contrived to get upon a patch of hard ground—the gravel comes to the surface in this locality—and before it could make its way below the stony ground, it was pounced upon and secured. The little captive was not in the least injured, and I transferred him to a rather large box, which I placed in the garden.

He ran about the box with great agility, thrusting his long and flexible snout into every crevice, and paying especial attention to the corners, in each of which he scratched perseveringly for some minutes. Seeming at last to make up his mind that he could not escape, he screwed himself into a corner, poked his muzzle into the darkest recess, and remained motionless as if dead. I then quietly introduced a few spadefulls of earth into the box, and scattered a little of the fresh soil under the creature's nostrils. New life seemed to be infused into the mole by the contact of the earth, and, Antæus-like, he inspired fresh vigour from the touch of mother Tellus.

The mole traversed the box with wonderful rapidity, pushing his way through the loose soil, entering and re-entering the heap, and in a few moments had scattered the earth tolerably evenly over the box. Every now and then the whole skin gave a quick convulsive shake, which had the effect of throwing the loose earth from the fur. This peculiar shake, or twitch, was really a curious sight. At one moment the mole was grubbing away, hardly to be distinguished from the surrounding soil, so completely was the fur covered with the dusty particles; suddenly a spasmodic shudder passed through the body, and in a moment the moving dust-heap had vanished, and in its place was manifest the soft, velvet coat of the mole.

The creature was unremitting in his attempts to escape from the box. After satisfying himself that he really could not burrow through a deal-board—a lesson which was not learned until after many attempts and as many failures—the creature tried to scramble over the sides, and stood perseveringly on his hind legs, scraping pertinaciously at the smooth wood, and ever and anon slipping sideways, and coming on his fore-feet.

The mobility of the long snout is really astonishing. The animal moves quickly about with an uncertain kind of gait, now to one side and now to the other, popping the nose here and there so rapidly that the eye can hardly follow its movements.

The senses of sight and smell seem to be practically obso-

lete. I placed a worm upon the track of the mole, and though his nose came within the tenth of an inch of the worm, he did not seem to be aware of the presence of his prey. I tried this experiment eight or nine times in succession, and always with the same result; but if the nose or either foot happened to come in contact with the annelid, the mole flew round in a moment, flung himself upon the prey, shook the worm backwards and forwards with his paws, passed his snout rapidly over it, bit it here and there, and scratched it about until he got one end of it into his mouth; either end answered his purpose equally well.

He then began to eat it in a most voracious manner, arching his back, sinking his head between his shoulders, keeping his fore-feet close on either side of his mouth, and using them with great dexterity, just as a Chinese uses his chopsticks, cramming the writhing annelid into his jaws as fast as it was eaten. The crunching sound of his teeth making their way through the tough skin of the worm was audible at a distance of two yards, and a sort of fury seemed to actuate the animal; it ate as if savage with hunger, and as fast as I could supply it with worms, so fast did it devour them.

One worm was of huge dimensions, and the mole could make nothing of it for a long time. He trampled over it many times, passing the worm underneath his body from his fore to his hind feet in a very peculiar manner, scuffling it, as it were, backwards and forwards. He bit it in twenty places, left it, came back again, got each end successively into his mouth, and rejected them both, and altogether behaved in a manner that could not have been pleasant to the worm. All this time the mole was full of excitement and fiery activity.

At last, he seized the worm about an inch from the head, held it fast with his jaws, and with his feet pulled it asunder. He then dropped the severed piece, searched for its head, found it, and crunched it up. He then scrabbled about until he came upon the rest of the worm, and pouncing upon it, like a cat on a mouse, he pulled off another piece, ate it, and so proceeded until he had finished the worm in detachments. Whenever he swallowed the last morsel of the worm, he used to potter about the same spot for some little time, trying it over and over with his nose, and ever and anon returning to it. I fancy that this precaution is taken for the purpose of securing any fragments of the worm which may have been bitten off, worms being sometimes very brittle.

The creature had now disposed of six worms, some of moderate size, and one three times as long as the mole itself. He seemed as hungry as ever, so I set to work and dug up a fresh supply. I could still hear the animal scraping about the box,

and my cat heard the noise also, and became very uneasy, trying to lift up the lid of the box, and catch the inhabitant.

After reducing pussy to reason, and making him understand that moles were not mice, I proceeded to give the animal a second supply of worms. He was just as furious about them as he had been with the former batch, and ate them as rapidly as before; inclusive of the time occupied in digging up the worms, fourteen were eaten in thirteen minutes. The second batch consisted of ten worms, all rather large, and these were as quickly devoured.

Wishing to know whether he would eat the common Julus millipede, I put a fine one on his track. As soon as he felt its writhing form touch his feet, he pounced on it as he had done with the worms, and scrambled it under his nose. As soon, however, as the sensitive snout touched the millipede, the mole threw up his head, and with one of his fore-paws chucked—there is no other word that expresses the action—the julus on one side, flinging it about two or three inches away.

I tried this experiment several times, and always found that the mole flung the julus away in the same manner. There was something inexpressibly ludicrous in the change of manner that came over the animal whenever he found that he had seized a julus instead of a worm, and the contemptuous air with which the millipede was tossed aside was most absurd.

About 8 P.M. I resumed the fork and spade for the purpose of procuring the mole's supper. Having heard from popular report that a twelve hours' fast would kill a mole, I determined to afford the creature a bountiful supply of food late in the evening, and then to give him his breakfast about 5.30 or 6 A.M. next morning.

So I dug perseveringly until I had captured a large handful of worms, and about 9 P.M. I put them into the box. As the mole went backwards and forwards, he happened to touch one of the worms, and immediately flew at it. While trying to get its head into his mouth, he came upon the whole mass of worms, and flung himself upon them in a perfect delirium of excitement. He kicked them backwards and forwards under his body, he trampled over them, he pulled them about, and seemed so overjoyed at his treasure that he could not settle upon any one individual. At last, however, he caught one of the worms, and began to crunch it, the rest uncoiling their many folds, making their escape in all directions, and burrowing into the loose mould.

Thinking that the animal was now well supplied for the night, some two dozen worms having been put into the box, I shut him up with an easy conscience.

Now, it so happened that on the following morning the rain

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was falling, or rather being blown, in a perfect torrent. Hoping that every hour might bring some remission of the tempest, I waited until about 9 A.M., and then opened the box. Twelve hours had just elapsed since the mole had received his last supply of worms, and as he must have spent considerable time in hunting them about his box, I should think that at least another hour must have passed before the last worm was consumed. But, the mole was dead. He had not been dead very long; he was quite stiff, with one of his paws held out sideways, as if his last act had been to fling the julus away, and his nose, still flexible, was pressed upon the earth.

I much lamented his loss, but could not charge myself with neglect. I forgot to weigh the worms which he devoured, but as they would have filled my two hands held cupwise, I may infer that they weighed very little less than the animal who ate them. From the extreme voracity and restless movements of this creature, I can well comprehend the value of the mole to the agriculturist; firstly, as a subsoil-drainer, who works without wages, and, secondly, as the means appointed for keeping the prolific race of worms within due bounds.

Of course, the fur was filled with parasites, as is the case with all animals, and very tough parasites they were, refusing for a long time to succumb to the fumes of ammonia, and being only killed by a twelve hours' immersion in that potent vapour.

Being desirous of turning the dead animal to the best account, I determined to try my hand again at preserving the skin after Mr. Waterton's system. I have already tried a water-vole, and failed very completely, but hope that this time the defeat will be less conspicuous.

As the fur was slowly drying after its immersion, I was surprised to see that a decided reddish tint was perceptible upon its surface. Thinking that this effect might have been produced by the reflection from some coloured substance, I moved it to another window, but found that the colour was visible whenever the light fell obliquely upon the fur. The tint is exactly that of a copper teakettle just where the copper changes into red, and whenever the light falls diagonally upon the fur, a rich green gloss plays fitfully over the soft hairs. These effects were not visible before the fur was thoroughly washed, and even the gray-brown tints seemed to deepen notably after the cleansing process which precedes the skinning of quadrupeds intended to be mounted upon that system.

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OPHRYDIUM VERSATILE.

BY REV. W. HOUGHTON, M.A., F.L.S.

(*With a Tinted Plate.*)

A FEW remarks on this extremely interesting form of infusorial life may be acceptable to the readers of this magazine, many of whom, it is probable, have never been fortunate enough to see these bright green balls to which Ehrenberg has given the name of *Ophrydium versatile*. I find immense numbers of these balls in the clear water of a canal near my house, and should be happy to send specimens to any microscopic readers of the INTELLECTUAL OBSERVER, who may be particularly anxious to make the acquaintance of our versatile friend, provided such requests do not come in overwhelming numbers. At first sight an observer would be inclined to refer these vividly green masses to the vegetable kingdom; indeed, some years ago, botanists did claim them for their own, and gave the production in question the appropriate name (so far as external form is concerned) of *Nostoc pruniforme;* but no apple or green-gage plum is worthy, in point of colour, to be compared with good specimens of *Ophrydium*.

In Pritchard's last edition of the *Infusoria* (p. 598) *Ophrydium* is arranged with the genera *Tintinnus*, *Vaginicola*, and *Cothurnia*, and forms with them the family *Ophrydina*. This is Ehrenberg's arrangement, which, however, is very unsatisfactory. Stein and Dugardin refer the four genera just named to the *Vorticellina* group; it is, I think, impossible to study the characters of the individuals which belong to those genera, and not feel convinced that their true affinities are with that family.

There is very great difference of opinion with regard to the classification of the infusoria, and the various systems which have been proposed must, as Mr. J. Reay Green observes, "be regarded as premature, since we know so little of the life history of these animals that it is by no means improbable that many apparently distinct species are nothing more than transitional conditions of more adult forms." We may, however, I think, refer *Ophrydium* to the *Vorticellina*, without being very far from the mark. Fig. A represents a couple of *Ophrydium* balls attached to a piece of *Anacharis alsinastrum*. So far as I am aware one species alone of *Ophrydium* has been described, viz., *O. versatile*. It is thus characterized in Pritchard's *Infusoria*:—"Body fusiform, tapering to a fine extremity from behind the middle, and anterior to it contracted into a cylindrical neck, supporting a funnel-shaped head, surmounted by an annular peristom, with a ciliated rotary disc. The mouth opens into a narrow

and long ciliated œsophagus. The contractile vesicle is seated near its end; the nucleus is long, narrow, and twisted. The external surface is thrown into close annular folds; and usually three longitudinal plaits extend from the posterior end as far as the middle of the body, which disappear when the body contracts. A subjacent cortical lamina is evident, and imbedded within this, numerous chlorophyll utricles, giving the animal a vivid green colour. When contracted, the body assumes the form of a long-necked flask, and even the nucleus shortens itself. In more complete contraction the figure becomes oval or globular. Fission is only longitudinal. When an *Ophrydium* quits its hold after fission, it swims away by means of a temporarily developed posterior wreath of cilia, just like a *Vorticella*. It is found encysted, and Stein believes in an acinetiform phase. Vividly green and associated in smooth and globular clusters or masses, which vary in size from a pea to a ball five inches in diameter; they are either free or attached. Ehrenberg states that in May, 1837, he saw hundreds of clusters as large as the fist, which, by the evolution of gas, were at intervals elevated to the surface, and driven by the wind to the edge of the water. In sea-water, also found by Brightwell, in fresh-water, and in a small turf pit, upon tendrils of roots of marsh plants, and the stalks of the white water-lily. Length of single animalcule stretched out, 1-120″ to 1-90″."

From this description it appears that *Ophrydium versatile* is an inhabitant both of fresh and salt water. I have never seen it in salt water, but have met with it in canals and ponds. It may be found throughout the whole of the year, and I have even obtained large specimens from water which had been frozen over; but in March and April the specimens appear to be most abundant, and the most beautiful both in form and colour. Fig. I represents a single individual magnified about 400 diam.; the parts referred to in the description given above are clearly visible. The animalcules are imbedded in a nearly colourless (not "greenish," as Mr. Reay Green states) gelatinous substance; it is the animalcules themselves that give the green colour to the whole ball; they project their anterior extremities beyond the surface of the jelly-like mass, and are firmly attached to its substance by means of a very long non-contractile tail or peduncle, which breaks off from the body when the individuals take to a wandering mode of life. The gelatinous substance, which is homogeneous in nature, and not composed of numerous little cells as Ehrenberg has stated, is often slightly coloured with brown, which colour is caused by a parasite species of Alga that sends forth its long twisting filaments into the substance of the ball. The free animalcules, which are extremely lively little creatures, swim about by means of their *anterior cilia*,

and remind one forcibly of the *Stentors*, only that these latter are *surrounded* with cilia, while the free *Ophrydia* possess *anterior* cilia *alone;* in this respect they differ from the true *Vorticellæ*, which develope a *posterior* fringe of cilia before the individuals leave their spiral stalks. I have never seen anything like a posterior fringe of cilia belonging to a free *Ophrydium*, but have observed a peculiar minute setiform appendage at this extremity as represented in fig. C *c*.

If an *Ophrydium* ball be placed in a vessel of water, and be kept in a sitting-room, the animalcules in a few days will leave the gelatinous substance and swim freely about for a time, when they again attach themselves to the bottom and sides of the vessel in small radiating clusters (see fig. G), which, I believe, represents an early stage of globe-like growth. I have never seen the encysted state of an *Ophrydium*. In most of the infusoria are to be seen certain clear spaces of a circular form; these are termed "contractile vesicles," and "vacuoles." These are very readily observed in *Ophrydium versatile*. The "contractile vesicle" (fig. I *d*), which is supposed to be filled with some clear fluid, and which some suppose may serve the purpose of a rudimentary circulation, is situated in *Ophrydium*, near the termination of the œsophagus, and dilates and contracts pretty regularly at intervals of eight or ten seconds; the "vacuoles" may readily be distinguished by their non-contracting and dilating properties. The "nucleus," which in *Ophrydium* is an elongated twisting band, and always filled with granular contents, may readily be observed by crushing an individual between two pieces of glass, when the solid "nucleus" will appear. It is now well known to microscopists that the so-called "nucleus" and "nucleolus" of the infusoria have been most satisfactorily proved to be the "ovary" and "testis," by the researches of M. Balbiani.

References to Plate.—A. *Ophrydium versatile* attached to *Anacharis alsinastrum*. B. Portion of surface of ditto seen through lens. C. Free individual swimming by means of anterior cilia. D. Individuals in various forms. E. Granular contents escaping. F. In process of longitudinal division. G. Showing mode of increase. H. Filamentous alga. I. Individual *Ophrydium* magnified 400 diameters:—*b*, mouth surrounded with cilia; *c*, ciliated œsophagus; *d*, contractile vesicle; *e*, nucleus long and twisted; *f*, annular folds of external surface; *g*, longitudinal plaits; *h*, chlorophyll utricles; *i*, vacuole; *j*, non-contractile peduncle.

XUM

ALLOTROPY.

BY W. B. TEGETMEIER.

THE singular phenomena which are known to chemists under the title of Allotropy are so remarkable, and can be so easily illustrated by means of a few simple experiments, capable of being performed without any particular apparatus, that they may advantageously form the subject of one of the series of practical papers that were commenced in a former volume of the INTELLECTUAL OBSERVER.

The term Allotropy is employed to signify the remarkable circumstance, that the same substance can exist in two or more totally different states, which are distinguished from each other by extraordinary variations both in their physical and chemical properties. The same substance, for instance, may be in one state fearfully poisonous, in another perfectly harmless. In one condition it may be brittle, in another extremely elastic. Again, it may have a liquid and several solid states, being in one vitreous or glassy, in another crystalline, and in a third perfectly amorphous. These singular changes of condition are the more remarkable from the fact that any one may be produced at the will of the operator, each particular state being readily convertible into either of the others.

The most familiar examples of allotropic substances are the elements carbon, phosphorus, and sulphur. Of these the latter is most easily experimented upon, and as some new facts relating to its allotropic conditions have recently come to light, we will select it for illustrating this peculiar class of phenomena.

Common commercial sulphur, or that found native in several parts of the earth, is soluble in turpentine in most of the mineral oils, as benzine, and also in bisulphide of carbon; when crystallized, it exists in the form of elongated octohedrons. If a few pounds of the common sulphur be melted in a crucible and allowed to cool slowly until a crust forms on the surface (when the crust should be broken and the liquid exterior poured out), the sides of the cavity will be found to be lined with transparent yellowish needle-like crystals, having a totally distinct form from the octohedral variety, being in long oblique prisms. These crystals spontaneously change in the course of a few days and pass again into the first-named more opaque octohedral form, the crystals retaining their outward shape, but in reality being constructed of an aggregation of minute octohedrons.

This change from the transparent prismatic to the opaque octohedral form is one of great importance in the plastic arts. Sulphur, when melted at a low temperature, and first cast, pos-

sesses a considerable degree of transparency, and a fair amount of tenacity and freedom from brittleness. It can be readily cut or trimmed with a knife, having very much the consistence of a hard horny cheese. Advantage is taken of this by the makers of plaster medallions and the copiers of old coins and medals. They moisten a plaster medallion, or grease slightly the surface of a medal, and then, securing a paper rim around it, pour on melted sulphur. This solidifies into the transparent prismatic variety, and may be cut and trimmed into shape, serving as a mould in which new plaster copies may be cast. After a few days, however, the sulphur resumes its octohedral brittle form, and the attempt to use it as a mould when in this condition generally results in its being defaced in consequence of its extreme brittleness.

Other peculiar allotropic forms of sulphur are produced by melting it at different temperatures.

When heated to a degree not exceeding 120° Cent., sulphur forms an exceedingly limpid mobile liquid, that possesses the property of taking sharper casts than any other substance, hence its employment as previously mentioned.

If it is heated to a higher temperature, it becomes gradually darker and extremely thick and viscid, so that the flask in which it is being melted may be inverted without its running out. The greatest degree of thickness and viscidity is attained at a heat of about 250° Cent. If it be heated to a higher degree it becomes more liquid again, though never to the same extent as when at a lower temperature. If in this highly heated state it is poured in a thin stream into water, sulphur assumes the extraordinary form of a rich amber brown transparent substance, possessed of a very high degree of elasticity and capable of being drawn out into threads. In this extraordinary condition it is quite insoluble in bisulphide of carbon and other menstrua that so freely dissolve octohedral or common sulphur.

In the course of a few hours, however, it returns to the common brittle condition, the change being accompanied by the evolution of heat, and, what is very remarkable, this change may be instantly brought about by placing the elastic sulphur in boiling water.

In the elastic state, sulphur is evidently in the vitreous or glassy form. This form is dependent on the fact that the sulphur has united with a proportion of heat, which has become latent in effecting this change.

A very good illustration of the vitreous condition assumed by some allotropic substances exists in barley sugar. This is formed by boiling sugar with the smallest possible quantity of water capable of dissolving it when aided by heat; as thus formed it is, whilst heated, a soft vitreous substance, capable of

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being twisted in spiral sticks, or formed into any required shape.

The proof that this peculiar condition is owing to latent heat is very convincing. If a mass of moderately warm barley sugar be taken and pulled out to double or treble its length, then folded and pulled out again and again, it eventually loses its transparency, becoming converted into penides, or pulled sugar, as it is technically called. But to pass from the vitreous condition it must get rid of its latent heat, and therefore, as the change is accomplished, the whole mass throws out this hidden caloric, becoming so hot that the hand cannot hold it.

To return, however, to the elastic state of sulphur: this condition may be rendered much more permanent by the addition of the minutest portion of iodine to the sulphur whilst melting. The smallest particle of iodine renders the limpid melted sulphur of a dark colour, and seems to be retained in spite of the high temperature to which it is necessary to raise the sulphur previous to pouring it into water. This iodized sulphur is much more elastic than that which has been fused and cooled without the iodine.

By many chemical authors this elastic sulphur is called *plastic* sulphur, an absurd misnomer, inasmuch as plastic signifies that which can be moulded into any required form, certainly not a property of elastic sulphur; and, misled by this absurd title, one of the best known writers on chemistry states that it is in this condition that sulphur is used for taking casts!

These changes, though not all of which sulphur is capable, serve very well to show the remarkable allotropic changes of which many substances are susceptible. That the same body should, without any alteration of its composition, be able to exist in the apparently opposite states of extreme brittleness and high elasticity, of transparency and opacity, of solubility and insolubility, in octohedral and in prismatic crystals, in a state of extreme limpidity and in one of great viscidity, is a very remarkable circumstance, and one worthy of being investigated with much greater care than it has yet received.

ELECTRICAL RESEARCHES BY DE LA RIVE AND GASSIOT.

M. DE LA RIVE has transmitted to the French Academy an account of his researches into the phenomena of the transmission of electricity—obtained from a Ruhmkorff coil—through rarefied gases. He states that the gas on which he operates is placed in tubes 4 or 5 centimeters in diameter, and 15 to 100 centimeters* long; or in vessels 16 to 20 centimeters wide, and from 20 to 25 high. In the longest tube, the platina balls, serving as electrodes, may be approached or brought into contact, as the wires carrying them pass through leather collars. His experiments on the influence of rarefaction on resistance to the discharge agree pretty well with those of other observers, but he adds that when the rarefaction approaches that degree which corresponds with most perfect condensation, the gases on which he operated—hydrogen, nitrogen, atmospheric air—follow precisely the law of conduction, being inversely as length.

Remarking on the well-known appearance of stratification in air sufficiently rarefied to permit of continuous discharge, a phenomena that begins by slight striæ on the side of the positive electrode, he details the following observations:—

"It is with hydrogen that these striæ appear most quickly and sharply, when the discharge consists only of a rose-coloured thread two or three centimeters in diameter. Gradually, as the elastic force is diminished, the discharge enlarges as well as the striæ. Moreover, a black space, which is also seen to enlarge itself gradually, and which may reach five or six centimeters in length, separates the extremity of the luminous column from the negative electrode, which remains surrounded by a blueish atmosphere. The phenomena of stratification take place in precisely the same way whether the gas be dry, or more or less moist: it therefore does not depend on the elementary, or compound nature of the medium. At a very slight pressure of one or two millimeters, the annular divisions, alternately dark and luminous, which form the striæ, become immoveable and very narrow (a quarter of a millimeter in breadth), while under a stronger pressure they were animated with a decided oscillatory movement, and had a breadth extending to five millimeters. When the pressure is less than two millimeters, a gleam of pale rose appears in the black space, and some luminous rings, which contrast, by their immobility and sharply-defined contours, with the agitated striæ in the rest of the electric discharge; and even at a pressure exceeding

* It is time this word was naturalized, so we spell it English fashion. It is to be hoped our own vexatious measures will not endure much longer.

two millimeters, an attentive examination of the obscure portion reveals a pale light, sharply divided from the luminous stratified column of which it is the prolongation."

M. de la Rive goes on to state the effect of introducing an additional quantity of gas, corresponding to an increase of a quarter or a half of a millimeter pressure. If the introduction takes place on the negative side, annular rose-coloured striations of the same diameter as the column of the discharge appear in the dark space. They gradually propagate themselves through the tube, and entangle* themselves with the primitive striations, which are much broader and less defined. When the supply of fresh gas is stopped, the luminous column slowly removes itself from the negative electrode, and soon regains its primitive appearance. Introducing the gas at the positive electrode, gives rise, in lieu of striæ occupying all the breadth of the tube, to a brilliant jet of very small diameter (two or three millimeters), advancing along the axis of the tube in "the relatively obscure interior of the luminous column, which immediately occupies all the black space in the vicinity of the negative electrode." These experiments M. de la Rive considers to confirm the opinion of M. Riess, that the stratifications are purely mechanical phenomena, resulting from the alternate contractions and expansions produced in the rarefied fluid by the discontinuous character of the electric discharge. He adds that this is shown by the employment of a manometer in connection with the tube, when oscillations varying from $\frac{2}{10}$ to $\frac{4}{10}$ of a millimeter reach a maximum of amplitude, at the moment when the gas reaches the degree of rarefaction at which the striation appears.

In further explanation, M. de la Rive observes that in the rarefied column those bands which are the best conductors remain dark, while those which offer most resistance become luminous; just as in the case of a chain of alternate links of platina and silver, the former become incandescent, while the latter remain cold. To prove this experimentally, he placed in the tube two small disks of platina, so that one should be immersed in a dark space and the other in a light one when the discharge was made. These disks acted as "sounds," and wires connected with them afforded a weak current from the dark spaces, and a stronger one from those which were luminous. He also found a difference of temperature in the two portions of the discharge.

"When a long tube containing hydrogen, at a pressure of eight millimeters, is placed axially or equatorially between the poles of a powerful electro-magnet, the conducting power of the medium diminishes from 30° to 10° if the dark space is near

* En s'enchevêtrant.

the magnetic poles; it does not vary if the part of the discharge near the positive electrode is near the poles, and it diminishes from 30° to 25° if the middle of the luminous column is submitted to the action of the electro-magnet. This effect is evidently due to the concentration produced by the magnet in the obscure portion of the column, for the medium in becoming more dense grows luminous at the same time."

Another point on which M. de la Rive touches, is the "action exerted by magnetism when the electric discharge takes place in a gaseous medium, between the extremity of a magnetized bar of soft iron and a circle of which its extremity is the centre. At a certain degree of rarefaction the electricity manifests itself in the form of a luminous jet, which turns like the hand of a watch with great regularity, and a velocity which may reach one hundred turns a minute. The direction of the rotation depends on that of the magnetization, and on the direction of the current; but if a change in the direction of the magnetization only modifies the direction of the rotation without altering its velocity, a change in the direction of the current modifies both the direction and the swiftness of the rotation. This swiftness is always less when the circle forms the negative electrode than when it forms the positive, which probably arises from a greater friction that results from the spread of the jet over the surface of the circle. The difference of velocity is much greater when the medium is more rarefied, and the spreading (*épanouissement*) of the jet from the negative electrode is more considerable with air impregnated with vapour, there being in one minute at a pressure of—

Pressure in millimeters.	Circle positive.	Circle negative.
8	100 turns	52 turns
10	72 „	46 „
12	62 „	44 „

At a certain degree of rarefaction the presence of vapour causes the jet to divide into several jets instead of spreading, and then to revolve like the spokes of a wheel. M. de la Rive ascribes this to a difference of molecular arrangement in air and in vapour.*

Thus far M. de la Rive, who does not seem to have made himself acquainted with the important paper on Stratified Discharges, communicated by Mr. Gassiot to the Royal Society in 1862, and which was briefly noticed by us in our April number.

Mr. Gassiot's experiments were made with an insulated voltaic battery of 3360 cells. The stratified discharge was in appearance precisely the same as that obtained from the in-

* For further details see *Comptes Rendus*, April 13, 1863.

duction coil, and some remarkable results were obtained by the introduction of tubes of distilled water into the circuit. In this manner the number of striæ could be with absolute certainty controlled, the apparently continuous discharge of the battery eliciting the same phenomena of stratifications as the induction coil. Mr. Gassiot's paper, after describing many original and curious experiments, concluded as follows:—

"The form, or figuration of the striæ, and the positions they occupy in the vacuum-tube, appear by these experiments to depend upon two separate and distinct conditions:—

"1st. The power or energy of the battery.

"2nd. The state of tension of the highly attenuated matter through which the discharge is visible.

"The striæ can be controlled, their number increased or reduced, and their places or positions in the tubes altered by the introduction of measurable amount of resistance in the circuit; and thus they appear to indicate the amount of force of tension which exists in a *closed* circuit of the battery, as the divergence of the gold leaves of an electroscope denotes the evidence of tension *before* the circuit is completed.

"In my former communications to the Royal Society I have alluded to the direction of a force in the induction discharge from the positive towards the negative (*Phil. Trans.* 1858, p. 16, sections 57, 58).

"In 1859 I observed that there was also a tendency or indication of a force emanating from the negative wire (*Phil. Trans.* 1859, pp. 140, 142, 153, sections 68, 72, 99); the actual disruption of the particles from the negative terminal also indicates a force; and this disruption is as freely obtained by the continuous discharge of the battery (§ 16) as it is by the intermittent discharge of the induction coil.

"I have always observed that with the lowest state of intensity with which the discharge can be obtained from an induction coil, the striæ are wider apart, and the dark space between the positive and the negative is much extended; under some conditions of the discharge it is the negative, and not the positive, that assumes the dominant character.

"The form of the striæ in the battery discharge, as observed in No. 315, figs. 7, 8, and 9,* presents an appearance somewhat analogous with the stationary undulations which exist in a column of air when isochronous progressive undulations meet each other from opposite directions, and on the surface of water by mechanical impulses similarly interfering with each other.

"*May not the dark bands be the nodes of undulations arising*

* These figures are published in *Proceedings of the Royal Society* for December 11th, 1862.

from similar impulses proceeding from positive and negative discharges?

"Or can the luminous stratifications which we obtain in a closed circuit of the secondary coil of an induction apparatus, and in the circuit of the voltaic battery, be the representation of pulsations which pass along the wire of the former and through the battery of the latter, impulses possibly generated by the action of the discharge along the wires?"

We have appended Mr. Gassiot's remarks to the account given by M. de la Rive of his researches for the sake of comparison. It seems to us difficult, if not impossible, to accept all M. de la Rive's views, and we should like to know whether any practical electrician has succeeded in repeating the experiments by which he imagines he has proved that the dark and light spaces in the circuit resemble the good and bad conducting links of a silver and platina chain. The subject is a highly curious one, and, though we recognize M. de la Rive's great merit in this branch of science, the theory he has propounded demands further investigation. Notwithstanding the great interest and beauty of electrical pursuits, they have fallen into singular neglect amongst the cultivators of science, so that there are now comparatively few private students either in England or France who devote to them the attention they deserve. This is to be regretted, as, though much has been done, more remains to be accomplished, and, so far as apparatus goes, such excellent means were never before placed within our reach.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY CHARLES CHAMBERS.

1863.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		Rain—read at 9·30 A.M.
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°			inches.
April 1	30·065	43·0	31·5	·67	·196	52·3	28·6	23·7	0, 3, 4	SE by E, E by N, E by N.	·000
„ 2	30·107	46·7	31·5	·59	·196	55·4	30·3	25·1	2, 0, 0	NE by N, N by E, NW.	·000
„ 3	...	...	...	...	...	59·3	31·7	27·6	...	...	·000
„ 4	29·947	45·6	40·8	·85	·272	54·0	39·4	14·6	10, 10, 3	SW, W by S, WNW.	·000
„ 5	...	...				53·0	36·4	16·6	...	...	·025
„ 6	29·578	45·5	42·1	·89	·284	55·3	47·2	8·1	10, 10, 10	SSW, SW by S, SSW.	·006
„ 7	29·491	43·0	35·5	·77	·226	53·5	41·1	12·4	6, 6, 9	SW, SW by S, S by W.	·050
„ 8	29·656	45·1	43·0	·93	·293	52·2	34·6	17·6	7, 10, 10	SW by W, SSW, SSW.	·010
„ 9	29·775	49·4	48·9	·98	·359	55·4	48·1	7·3	10, 10, 10	SSW, S by W, S by W.	·083
„ 10	29·749	52·7	50·1	·92	·374	61·5	49·7	11·8	10, 9, 6	S, S by W, S by W.	·034
„ 11	29·835	48·9	43·8	·84	·302	57·7	49·3	8·4	8, 10, 10	NW by N, N, N.	·000
„ 12	...	...	...	...	...	58·7	46·9	11·8	...	...	·010
„ 13	29·963	48·6	35·5	·63	·226	56·4	42·3	14·1	9, 2, 5	E by N, ENE, E by N.	·000
„ 14	29·913	45·8	42·7	·90	·290	56·7	38·2	18·5	10, 7, 8	SE by E, S by E, —.	·000
„ 15	29·983	50·1	39·6	·70	·260	59·9	33·3	26·6	4, 4, 9	W, S by W, —.	·000
„ 16	28·992	53·3	42·9	·70	·292	62·5	43·0	19·5	10, 8, 9	—, NW by N, NNW.	·000
„ 17	30·109	53·1	41·2	·67	·275	61·1	42·2	18·9	1, 4, 3	NW, W, W.	·000
„ 18	30·206	51·3	42·7	·75	·290	59·0	47·5	11·5	10, 3, 2	SW by S, NE, NNE.	·000
„ 19	...	...	...	...	...	60·5	33·5	27·0	...	...	·003
„ 20	29·852	53·8	42·7	·68	·290	63·4	37·6	25·8	8, 8, 3	S byE, SW by S, WSW.	·000
„ 21	29.829	49·9	41·7	·75	·280	57·0	37·4	19·6	3, 10, 10	SW by W, WSW, WSW.	·000
„ 22	29·745	51·4	38·4	·64	·250	59·4	47·5	11·9	10, 7, 3	WSW, W by S, W by N.	·003
„ 23	30·114	48·2	27·1	·48	·167	54·7	39·6	15·1	3, 7, 3	NW, NNW, NW.	·010
„ 24	30·358	47·9	28·7	·51	·177	57·3	34·0	23·3	1, 6, 10	NW byW, NW byW, WNW	·000
„ 25	30·266	53·6	41·1	·65	·275	62·7	45·1	17·6	10, 4, 3	W by N, W, W by N.	·000
„ 26	...	...	...	...	...	63·7	39·6	24·1	...	...	·000
„ 27	30·032	53·8	40·2	·63	·266	62·0	40·0	22·0	0, 7, 6	W, W by S, WSW.	·000
„ 28	29·790	45·3	30·4	·59	·188	55·3	46·3	9·0	10, 5, 3	W, NW by W, WNW.	·000
„ 29	29·874	41·7	34·8	·79	·220	49·7	39·4	10·3	10, 9, 7	NW, N by E, NW by N.	·057
„ 30	30·128	39·7	35·8	·87	·228	51·2	38·1	13·1	9, 10, 10	NE by N, NE, NE by E.	·010
Monthly Means.	29·934	48·3	38·9	·74	·259	...	...	17·1	...	...	0·301

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—April 1863.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour.																															
A. M. 12	10	2	2	6	8	30	17	8	11	1	8	6	12	13	6	3	2	1	2	1	8	23	5	7	9	5	5	8	13	15	8·2
1	9	2	4	6	8	30	18	9	9	3	7	7	9	5	3	2	5	5	2	2	7	17	9	6	7	4	3	7	8	15	7·6
2	6	1	3	7	7	25	16	8	8	2	9	6	7	1	1	1	3	4	1	2	6	23	9	5	10	5	3	9	6	13	6·9
3	3	1	3	6	10	20	11	9	6	4	7	9	5	4	1	4	4	7	2	1	6	22	7	7	8	5	7	9	9	15	7·1
4	3	1	4	5	10	24	8	6	9	4	4	10	7	3	1	1	4	5	3	3	8	25	9	3	7	4	5	11	3	14	6·8
5	5	1	3	6	11	21	10	6	9	7	4	11	7	1	1	4	3	7	5	1	7	27	6	7	8	4	3	13	7	16	7·4
6	6	2	3	9	15	24	12	8	14	9	3	11	10	1	2	1	2	7	1	1	11	26	9	4	9	5	7	10	12	15	8·3
7	6	2	3	13	19	27	10	9	16	10	3	12	18	9	2	2	5	7	5	3	14	27	15	9	11	8	11	15	16	17	10·8
8	8	4	2	16	20	30	13	12	18	11	5	14	18	8	5	2	4	11	4	3	13	26	18	13	13	9	12	18	19	16	12·2
9	10	8	4	16	17	31	16	17	19	14	7	12	17	5	8	3	5	15	8	2	18	24	20	11	18	8	15	18	16	19	13·4
10	10	13	4	18	23	26	15	20	17	14	7	13	20	6	2	6	7	13	8	5	18	20	21	13	15	8	20	15	15	15	13·6
11	11	10	3	17	21	29	18	18	21	14	9	17	21	4	3	9	9	11	9	13	24	23	23	12	20	10	20	18	18	15	15·0
12	10	10	5	16	21	31	21	14	23	16	17	18	24	5	3	10	9	9	9	14	21	22	20	13	20	11	23	17	19	20	15·7
P. M. 1	9	9	4	17	24	28	22	18	21	13	13	17	24	5	3	9	11	12	10	18	15	24	21	12	19	11	22	23	18	24	15·9
2	15	10	3	14	26	26	20	21	19	14	17	11	21	7	6	7	11	13	12	14	17	24	20	14	19	9	20	20	21	19	15·7
3	21	8	6	12	23	26	21	19	17	10	12	22	17	11	5	7	10	12	9	13	16	18	20	16	17	11	17	22	22	17	15·2
4	17	9	2	11	25	25	18	18	15	9	13	22	18	7	4	7	11	15	11	12	16	21	20	16	16	9	18	21	20	14	14·7
5	19	9	2	14	23	22	20	15	13	7	10	15	18	10	4	7	7	15	10	12	17	18	19	14	16	9	15	19	21	11	13·7
6	18	3	3	9	25	18	17	11	10	6	8	15	12	10	3	3	1	17	8	10	13	15	14	12	10	3	16	18	16	10	11·1
7	14	4	4	5	24	14	14	9	10	10	7	14	12	10	3	3	2	13	7	9	16	9	22	9	9	1	12	12	13	12	10·1
8	9	8	3	5	27	8	11	11	3	11	3	14	9	10	4	3	3	11	6	6	15	8	10	6	6	2	10	12	19	18	9·0
9	8	6	5	4	27	7	8	9	5	8	5	12	12	8	2	5	4	4	3	9	20	8	10	10	6	4	8	9	9	16	8·4
10	3	2	6	6	29	10	7	10	3	6	3	13	9	5	3	6	5	5	1	8	22	8	11	8	5	4	7	10	9	5	7·6
11	2	2	5	7	30	10	8	12	6	7	3	12	10	7	3	4	4	2	1	7	20	8	7	9	5	3	5	11	10	5	7·5
12																															
Total Daily Movement.	232	127	86	245	473	542	351	297	302	210	184	313	337	155	78	109	131	221	137	169	348	466	345	236	283	152	284	345	339	356	10·9

Rain-fread at 9·30 A.M.	inches.	·000	·000	·000	·000	·025	·006	·050	·010	·083	·034	·000	·010	·000	·000	·000	·000	·000	·000	·003	·000	·000	·003	·010	·000	·000	·000	·000	·057	·010	0·301

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863. Day of Month.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		Rain—read at 9·30 A.M.
	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°			inches.
May 1	30·224	46·0	32·5	·62	·203	54·7	31·3	23·4	2, 3, 2	NE by E, E by N, E.	·083
„ 2	30·073	50·2	35·2	·59	·223	59·3	35·2	24·1	0, 6, 6	NE, NE by E, NE by N.	·000
„ 3	...	...	...	...	...	63·9	40·5	23·4	...	... ...	·000
„ 4	29·803	56·3	44·4	·67	·308	65·8	49·1	16·7	10, 7, 8	W, WSW, WNW.	·000
„ 5	29·857	53·6	45·3	·75	·318	64·8	46·8	18·0	3, 10, 7	WSW, NW by W, NW by N.	·000
„ 6	29·997	54·9	41·1	·62	·275	65·4	41·5	23·9	8, 8, 2	WNW, SSW, SSW.	·000
„ 7	30·162	54·0	42·4	·67	·287	62·7	45·0	17·7	10, 2, 1	NW by W, N, NE by N.	·000
„ 8	30·311	48·9	36·1	·64	·230	58·6	37·3	21·3	4, 0, 2	E, SE by E, E by N.	·000
„ 9	30·005	54·7	42·8	67	·291	64·4	38·0	26·4	9, 10, 3	NE by N, S by E, —.	·000
„ 10	..	...	...	...	...	60·3	41·4	18·9	...	... ...	·007
„ 11	29·981	49·7	36·0	·62	·230	58·5	41·7	16·8	6, 10, 10	SW by W, SW, SW.	·000
„ 12	29·687	48·6	48·9	1·00	·359	55·6	48·4	7·2	10, 10, 10	SW, SW, SSW.	·118
„ 13	29·627	52·3	45·3	·79	·318	61·2	50·1	11·1	6, 8, 10	SSW, SW by S, SW by W.	·181
„ 14	29·866	51·8	42·8	·73	·291	60·2	46·6	13·6	9, 10, 10	WSW, SW by W, SW by S.	·052
„ 15	29·782	53·3	50·3	·90	·377	61·0	50·5	10·5	10, 10, 3	SW by S, S by W, SW by W.	·063
„ 16	29·901	52·1	44·2	·76	·306	61·0	47·4	13·6	9, 10, 10	SW by S, SW by S, SW.	·100
„ 17	...	...	...	...	...	59·9	47·3	12·6	...	... ...	·005
„ 18	29·876	50·1	44·6	·83	·310	59·5	41·4	18·1	9, 10, 10	NE by N, E by N, NE by E.	·008
„ 19	29·895	40·9	35·3	·82	·224	47·2	42·8	4·4	10, 10, 10	NE by E, NE by E, NE by E.	·323
„ 20	30·070	45·1	40·4	·85	·268	52·7	42·8	9·9	10, 10, 10	NE by N, NE by N, N by E.	.220
„ 21	30·165	48·8	40·2	·74	·266	55·2	46·1	9·1	10, 10, 10	NE by E, NE, ENE.	·217
„ 22	29·994	45·1	33·7	·67	·212	52·8	39·0	13·8	10, 10, 6	NE by E, ENE, NE by E.	·003
„ 23	29·836	47·7	36·7	·68	·235	57·1	37·7	19·4	7, 6, 6	E by N, NE by N, NE by E.	.000
„ 24	...	...	...	...	...	59·9	37·0	22·9	...	... ...	·000
„ 25	29·964	47·9	37·0	·68	·238	55·8	41·0	14·8	7, 10, 10	N by E, NE by N, N by E.	·000
„ 26	30·172	48·0	35·6	·65	·226	58·2	37·0	21·2	10, 5, 4	N by W, E by N, NNE.	·000
„ 27	30·240	57·2	41·2	·58	·275	65·2	36·3	28·9	0, 5, 7	W by S, W, W by N.	·000
„ 28	30·244	59·3	47·0	·66	·337	70·4	46·5	23·9	2, 3, 7	NW, —, W by N.	·000
„ 29	30·174	63·4	53·5	·72	·420	74·7	49·6	25·1	3, 3, 2	W by S, W by N, W by N.	·000
„ 30	30·134	62·0	54·8	·79	·439	70·5	54·1	16·4	10, 10, 10	W by N, W, W by N.	·000
„ 31	...	...	...	...	...	56·8	52·8	4·0	...	... ...	·013
Monthly Means.	30·002	51·6	41·8	·72	·287	...	...	17·1	...	... ...	1·393

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER—MAY 1863.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																	
12																																	
1	A.M.	3	8	6	3	10	4	3	2	8	2	3	20	11	18	18	14	6	1	25	24	10	8	7	4	9	2	2	4	6	6	4	8·1
2		3	6	5	2	7	6	7	2	6	5	4	25	12	15	13	9	6	3	25	17	9	10	6	1	8	4	1	5	3	2	6	7·5
3		3	7	8	2	6	4	5	3	3	3	3	25	10	18	13	10	6	2	25	18	11	6	10	4	8	2	1	4	4	6	5	7·6
4		4	5	9	3	7	6	5	3	3	4	1	26	5	16	10	12	3	2	25	20	12	10	10	3	8	2	2	5	4	6	3	7·6
5		2	7	8	4	10	4	3	2	2	5	2	24	6	16	9	13	4	1	25	19	11	11	10	3	12	4	3	7	5	4	5	7·8
6		2	6	1	1	8	6	6	1	1	2	5	14	8	11	9	16	7	2	30	16	10	13	9	6	13	3	2	5	6	4	5	7·4
7		2	10	7	3	11	5	7	7	2	1	7	12	9	16	10	19	8	3	30	13	14	18	13	7	17	9	3	6	7	6	7	9·3
8		12	14	9	10	16	6	9	12	7	8	8	11	16	13	11	25	10	5	28	11	15	25	20	10	20	12	3	7	7	5	13	12·2
9		16	17	9	8	16	3	8	8	5	10	7	16	19	14	14	29	9	9	30	8	18	20	18	10	18	12	7	5	9	4	14	12·6
10		15	13	9	6	17	3	8	16	10	10	10	17	21	16	15	17	9	11	32	8	17	17	19	8	14	11	7	6	8	4	13	12·5
11		11	20	10	10	18	4	10	17	13	13	12	23	20	14	19	17	10	13	38	10	19	18	15	7	16	8	8	5	9	8	13	13·8
12		14	21	10	7	19	5	12	14	11	13	11	30	27	16	19	18	17	17	39	8	18	22	16	7	19	9	10	6	11	9	10	15·0
1	P.M.	17	24	9	10	19	6	9	14	12	12	14	30	29	18	14	21	17	14	43	8	19	17	15	9	22	8	10	9	13	9	11	15·5
2		14	25	10	12	19	10	12	18	7	14	18	29	29	22	13	20	18	12	43	3	19	20	16	11	21	9	11	8	13	10	12	16·1
3		19	25	7	11	15	12	11	17	9	14	21	25	32	23	15	20	13	11	37	8	16	18	14	9	22	6	9	6	13	9	9	15·4
4		21	25	9	11	10	16	11	19	3	13	22	22	31	20	22	20	12	11	35	7	15	17	15	10	16	9	10	9	13	11	8	15·3
5		18	25	8	11	9	12	16	21	1	11	25	21	31	23	26	13	13	16	38	6	15	21	12	11	17	7	12	9	11	9	10	15·3
6		14	21	8	8	5	9	16	16	1	10	24	20	20	18	24	13	12	12	35	15	17	17	10	9	15	8	10	8	10	8	11	13·7
7		15	20	2	8	7	10	15	19	5	6	23	21	15	14	10	13	7	23	36	6	17	16	9	9	14	6	7	6	9	8	7	12·4
8		10	17	2	6	8	9	11	13	4	4	21	23	14	14	10	10	6	22	31	5	20	17	4	8	12	3	6	4	7	7	6	10·8
9		7	13	1	9	5	5	14	7	3	7	21	17	10	18	8	4	6	21	28	7	13	15	7	8	12	1	3	3	7	7	7	9·5
10		9	14	1	7	4	5	12	9	1	7	18	19	11	25	7	6	6	20	32	10	9	15	5	8	7	2	6	4	5	6	11	9·7
11		11	8	1	7	6	5	9	10	2	7	25	15	12	29	11	7	5	23	37	10	9	10	7	4	8	2	5	6	6	4	14	10·2
12		7	6	4	8	9	4	5	9	1	5	25	12	7	19	14	7	3	24	24	10	6	7	3	10	5	1	3	5	3	3	12	8·4
Total Daily Movement.		249	357	153	167	261	159	224	259	120	186	330	497	405	426	334	353	213	278	771	267	339	368	270	176	333	140	141	142	189	155	216	11·4

Rain—read at 9·30 A.M.	inches.																																1·393
	·083	·000	·000	·000	·000	·000	·000	·000	·000	·000	·007	·000	·118	·181	·052	·063	·100	·005	·008	·323	·220	·217	·003	·000	·000	·000	·000	·000	·000	·000	·013		

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9.30 A.M.	Daily Range.	At 9·30 A.M., 2 P.M., and 5 P.M. respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
June 1	30·207	54·3	44·4	·71	·308	65·7	44·6	21·1	10, 4, 3	E, ——, E by N.	·000
„ 2	30·058	62·7	43·2	·52	·295	72·4	42·3	30·1	0, 1, 0	E, S by W, SSE.	·000
„ 3	29·950	65·0	51·6	·64	·394	76·1	46·0	30·1	5, 9, 10	S by E, SW by W, SW by W.	·000
„ 4	29·963	58·4	39·3	·52	·258	68·6	56·3	12·3	3, 10, 2	——, NW, NW.	·000
„ 5	29·872	50·8	50·1	·98	·374	62·3	45·7	16·6	10, 10, 10	W, SW, SSW.	·000
„ 6	29·407	51·6	49·7	·94	·369	63·4	52·6	10·8	10, 9, 9	SW, SW, WSW.	·901
„ 7	...	...	...	...	...	61·6	49·5	12·1	...	...	·167
„ 8	29·519	50·1	44·0	·81	·304	62·3	49·8	12·5	8, 7, 6	SW, SW, SW.	·157
„ 9	29·769	54·6	44·0	·70	·304	63·7	46·7	17·0	6, 7, 4	SW by S, SW by W, S.	·048
„ 10	29·467	55·9	50·2	·82	·376	66·1	49·8	16·3	10, 7, 8	ENE, SE, SSE.	·066
„ 11	29·538	53·4	42·6	·69	·289	61·9	49·6	12·3	7, 7, 10	SSW, S by W, SSE.	·098
„ 12	29·496	46·7	44·4	·92	·308	60·3	48·3	12·0	7, 10, 10	S by E, ——, ——	·321
„ 13	29·773	53·9	45·1	·74	·315	62·8	45.9	16·9	8, 6, 3	W by S, WSW, W.	·232
„ 14	...	...	...	...	...	64·9	45·3	19·6	...	...	·010
„ 15	29·975	57·2	49·3	·76	·364	66·3	55·7	10·6	10, 10, 10	WNW, WNW, W.	·094
„ 16	29·932	54·8	54·2	·98	·430	64·2	50·4	13·8	10, 10, 10	SSW, SW, SSW.	·003
„ 17	29·864	58·7	46·8	·67	·334	68·8	53·1	15·7	8, 5, 7	NW by W, W, W.	·260
„ 18	29·794	58·6	49·8	·74	·371	68·3	49·1	19·2	4, 10, 10	S by W, S, SE.	·000
„ 19	29·550	54·6	50·8	·88	·384	67·7	54·4	13·3	10, 7, 7	NE by N, SW, S by E.	1·246
„ 20	29·790	58·0	52·0	·82	·400	67·6	53·9	13·7	9, 7, 10	NE by N, NW, NW.	·048
„ 21	...	...	...	...	...	71·1	50·8	20·3	...	...	·000
„ 22	30·029	57·1	55·6	·95	·451	67·1	55·9	11·2	10, 10, 9	SW by W, S by W, S by W.	·009
„ 23	30·096	63·1	48·7	·62	·357	73·0	56·6	16·4	3, 4, 2	WSW, SW by W, WSW.	·000
„ 24	30·048	60·5	53·9	·80	·426	70·8	55·5	15·3	10, 5, 9	NW, N by W, NW.	·013
„ 25	30·110	60·4	47·4	·64	·341	71·3	56·5	14·8	10, 6, 3	NW, W by N, NW by W.	·437
„ 26	30·127	58·9	48·9	·71	·359	70·9	49·6	21·3	2, 9, 10	W by S, SW, NW by W.	·000
„ 27	29·929	57·3	51·1	·81	·387	67·7	51·7	16·0	10, 7, 2	SW, W by S, W by N.	·016
„ 28	...	...	...	...	...	64·7	46·6	18·1	...	...	·004
„ 29	29·979	57·1	43·5	·63	·298	66·9	48·3	18·6	7, 7, 9	SW by W, W by S, W.	·000
„ 30	30·207	57·0	43·1	·62	·294	66·8	46·4	20·4	7, 8, 1	WSW, W, W.	·037
Monthly Means.	29·863	56·6	47·8	·75	·350	...	...	16·6	...	... ...	4·167

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—JUNE 1863.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour. 12	13	7	3	5	6	23	12	10	5	25	11	4	4	7	6	4	7	3	17	4	12	10	1	8	8	2	10	7	4	7	8·3
1	7	4	2	4	5	18	13	11	5	23	10	8	5	5	4	6	5	2	5	5	10	6	6	1	7	2	8	4	4	6	7·2
2	4	3	2	5	5	17	12	9	6	20	12	5	4	4	4	2	3	2	16	3	16	7	2	3	4	2	18	3	4	6	7·1
3	3	2	1	5	5	14	10	9	5	20	11	5	4	6	2	4	3	3	13	4	11	4	1	4	4	2	20	4	3	7	6·5
4	2	2	3	5	7	15	9	8	6	18	11	5	5	8	4	7	5	3	11	5	11	5	2	5	5	1	13	6	3	7	6·5
5	1	2	1	5	7	12	8	6	6	15	12	5	5	8	4	8	5	2	9	6	11	5	2	6	5	1	11	7	4	6	6·7
6	2	3	2	6	9	13	9	6	5	15	11	5	5	8	4	9	6	3	9	6	11	6	3	6	6	1	16	7	4	6	7·1
7	4	4	5	7	11	9	6	5	5	13	10	5	5	8	4	11	6	4	8	6	11	6	4	6	6	1	17	8	5	6	7·6
8	7	6	5	9	13	8	5	4	6	11	9	6	6	8	4	12	7	5	6	7	11	6	5	7	6	2	15	11	7	8	8·4
9	9	7	6	12	16	11	7	6	6	9	7	6	6	8	4	14	8	6	9	8	11	6	6	9	7	2	18	11	9	7	9·3
10	8	7	6	15	21	15	10	8	6	6	6	7	7	10	6	16	9	7	14	9	14	7	6	8	7	3	20	13	12	11	10·5
11	5	5	4	13	16	15	15	8	6	8	8	10	8	13	2	4	7	8	11	4	11	5	5	8	8	5	19	11	11	11	10·8
12	4	4	3	12	21	15	17	16	8	6	9	15	10	12	9	7	9	8	11	5	15	6	6	9	9	4	18	12	14	13	11·5
1	5	7	5	12	20	18	23	26	15	24	6	13	11	10	12	10	9	8	12	6	15	8	5	11	9	5	18	14	13	12	12·6
2	7	4	3	13	20	20	27	27	23	26	9	17	9	12	9	12	9	9	16	9	18	9	6	12	11	6	19	13	11	13	13·5
3	11	14	9	16	23	28	22	21	13	27	1	18	10	12	10	13	8	7	17	10	19	11	6	15	12	7	19	11	12	14	14·0
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9	10	2	2	7	9	16	14	3	6	10	4	5	8	8	8	9	7	6	12	8	12	6	5	7	8	7	18	12	14	13	12·6
10	11	12	2	8	9	9	13	6	28	9	1	4	8	8	8	9	7	6	11	7	14	6	5	7	8	7	19	11	11	11	10·8
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12	7	4	8	8	21	10	14	11	8	9	9	8	7	4	8	5	5	5	10	4	12	5	4	6	6	4	17	7	4	6	7·6
Total Daily Movement.	200	208	139	199	389	333	365	421	292	323	450	181	250	172	228	202	184	153	241	180	254	329	123	102	141	163	350	199	187	202	9·9

A. M. P. M.

Rain—read at 9·30 A.M.

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THE STUDY OF MOSSES.*

THE most obtuse observer cannot wander through the country without admiring the beauty of mosses. In many places they carpet the ground with a rich living pile of pleasant green, in others they clothe the rocks, form a vesture for the tree-trunk, enrich the parti-coloured thatch on the quaint old cottage, or sedulously haunt the crevice of the wall. In a technological sense they are not of much use, except in the condition of peat; perhaps simply because man is not yet sufficiently instructed to know what to do with them: but in the world of nature they play an important part, making their appearance at times and under circumstances when higher forms of vegetation would not grow. Thousands and millions are the tons of mineral and aeriform matter which they transmute every season into their delicate tissues; and when these decay, they produce no inconsiderable amount of vegetable soil. They likewise form the home and shelter for numerous minute insects, even for rotifers; and they tell their story of the wonderful ways of life and organization not less strikingly than the widest spreading, or the loftiest soaring, of the stateliest families of trees. Like all low, or comparatively lowly members of the organic world, they contribute most importantly to our knowledge of the laws, processes, and structures that distinguish living beings. We cannot assert that they constitute a page of nature's primer, and furnish elementary lessons in A, B, C, for her human pupils to study; as little was known, or could be known of them, or of objects standing upon a similar or lower grade of structural rank, until science had been considerably advanced, and instruments like the microscope had been fabricated to assist in the delicate and complicated labours of research. The simplest form of life is not after all simple in any ordinary sense of the word. We talk of "unicellular plants and animals," but Professor Karsten† tells us this is erroneous, "owing to the complicated structure of the tissue cells which enter into the composition of developed organisms;" and if we mastered the structure of the cell, we should still be puzzled to account for the functions which it performs, some of which we know to be physical, while we call others "vital," without attaching any precise or definite meaning to the term.

Still, though nature's secrets lie always deep, we are

* *Handbook of British Mosses*, comprising all that are known to be Natives of the British Isles. By the Rev. M. J. Berkeley, M.A., F.L.S., author of "Introduction to Cryptogamic Botany," "Outlines of British Fungology," etc. Lovell Reeve & Co.

† See *Annals of Natural History*, No. 67.

materially assisted in unravelling them by the examination of objects that present fewest complications; and hence, among others, mosses are very useful to the scientific botanist, as they are sure from their beauty to interest the more casual observer. Unfortunately, they do not readily admit of any classification which is natural and intelligible. In the *Micrographic Dictionary*, which has a high reputation for its botanical articles, the system of Müller is followed, while Mr. Berkeley considers that the arrangement of Dr. Montagne in *D'Orbigny's Dictionary* is the most convenient as regards the natural orders, and he tells us he has adopted it with few exceptions. He arranges the mosses under four orders—*Pleurocarpi*, with the fruit lateral and springing immediately from the stem; *Acrocarpi*, with the fruit terminal; *Schistocarpi*, with the fruit splitting longitudinally into four or more valves, adhering above; and *Syncladei*, mosses with fasciculate branches. The artificial group, *Cladocarpi*, with terminal fruit on short lateral branches, he judiciously arranges under other heads, on the ground that "it is not strictly natural, and the character is difficult of application, as *Acrocarpus* and *Cladocarpus* species occur in the same genus."

The shape of the spore vessel or capsule, the form of the hood, the presence or absence of the peristome, and its exquisite rows of finely-coloured teeth, the shape of the cells forming the leaf tissue, and the mode of branching—these are the chief points to be attended to in the examination of mosses; but it is to be regretted that as yet no sufficiently dominating characters have been discovered to enable those who have devoted themselves to the inquiry to establish genera which are at once intelligible, and correspond with natural conditions.

Mr. Berkeley, who is no mean authority on these subjects, after devoting, as his present work proves, much attention to the question, tells us that "on the whole, the state of Bryology must be considered as extremely imperfect," and he adds, "the entire subject clearly wants the revision of some master mind."

The reproductive processes in mosses are very curious and characteristic. As is common with plants, and with many animals, they have two or more modes of multiplication—the one a genuine sexual process, the others belonging to the category of *budding*. In the elegant urns, which form such beautiful objects for the microscope, the moss produces *spores*; but the result of their germination differs materially from that of the spores of ferns. Mr. Berkeley thus comments upon this subject:—"In ferns and their allies, the result of germination is the production of a cellular expansion of various forms, whether globose, or scale-like, or irregular, whether more or less differen-

tiated and distinct from the spore itself, or confluent with it externally or internally, or both, on which, or within the substance of which, at least in the more normal cases, two organs are produced of different sexes, the one of which, called an "archegonium," consists of a pitcher-shaped cyst, within which there is a free single cell at the base, which is destined, after impregnation, to produce first an embryo, and then, by continued development, a perfect plant like the parent. . . . In mosses, on the contrary, and their allies, the object, after germination, is to form a more or less filamentous, or scale-like stratum, resembling either a little green lichen, or one of the verdant thread-like confervæ, such as *Lyngbya muralis*, which clothes damp trees or the soil at the base of walls on the northern side, or that which is least exposed to the direct rays of the sun; and when this is perfected, nodules appear, which by cell formation give rise to the proper plant, whether symmetrical or unsymmetrical, whose office is to produce fruit. On this plant, then, either in the same or in distinct individuals, male and female organs are produced, resembling more or less closely the antheridia and archegonia of ferns. In the latter there is a cell at the base analogous to that in the archegonia of ferns, which is destined to be fertilized by spermatozoids formed in the tissue of the antheridia." The result of the fertilization is, however, distinct from that of ferns, for in their case germination produced a prothallus and impregnation afforded a true plant, "whereas in mosses and moss allies the cell division of the basal cell of the archegon* is a sporangium, or, as it is frequently called, a capsule or theca, which, with various modifications, gives rise to spores."

Warmth and moisture cause moss spores to burst their outer membranes, when the inner one puts forth an elongation which forms a green thread, and from these threads fertile buds arise. The behaviour of these threads has attracted the attention of Dr. Hicks, but Mr. Berkeley does not accept that gentleman's conclusions. He says:—"Dr. Hicks, in the 23rd vol. of the *Transactions* of the Linnean Society has described wonderful changes which take place in these threads, and their conversion into several genera of algæ, besides the formation of zoospores; but as he does not identify the species to which he observed the threads belonged, and the production of zoospores is a circumstance so extremely anomalous, we find it difficult to believe that he had really portions of some moss before him, and not the threads of algæ accidentally intermixed."

Many mosses are readily cultivated, and afford elegant "adornments" for what our friend Shirley Hibberd calls

* The archegon is the rudimentary organ which represents the ovule in the higher flowerless plants.

"Homes of Taste." Mr. Stark gives a long list of these, amongst which are species of Hypnum, Orthoslichum, Polytrichum, Trichostomum, Andrea, Bryum, etc., etc. Of course the natural habits of the mosses must be considered, some liking a large allowance of moisture, and others preferring a situation that is dry.

We do not think it is any argument against a system of classification based on minute structure, that the determination of genera or species requires the aid of the microscope, as, thanks to the competition amongst excellent makers, instruments sufficient to follow the researches of others can be obtained for very moderate prices, and nine-tenths of the pleasure which the moss tribe, or any other small plants whose parts are minute, are able to afford to their admirers, must be obtained through the medium of considerable magnification. On this ground we confess to have some leaning towards the system of Müller, but every arrangement in the present state of the science must be regarded as provisional, and the consolation for those who have to take the trouble of getting up an elaborate nomenclature, to find it replaced a few years hence by another, must be found in the fact that they cannot study mosses upon any system without obtaining a large amount of positive information, which must remain valuable, whatever additions may be made to the store, or whether other genera are destined to suffer the fate of *Gymnostomum*, and find themselves properly distributed amongst widely distant groups.

In Mr. Berkeley's work the student will find the inestimable advantage of several hundreds of beautifully-executed coloured figures of native plants, and of their most important parts. By these he will be materially assisted in the determination of species, and also instructed what to see with the microscope in the arrangement and form of cells, the character of the spore vessel, the peristome, etc., etc. It is also proper to state that although Mr. Berkeley modestly disclaims originality, he has personally examined the objects described, and written his account of them with the especial purpose of assisting the collector of British specimens. The work is handsomely printed, and the coloured illustrations of unusual merit.

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THE SOURCES OF THE NILE.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S., ETC.

In our number for June appeared a brief notice of a few words, announcing the intelligence that Captain Speke had succeeded in identifying the African lake, Victoria Nyanza, before visited by him, south of the equator, with the great father of waters, old Nilus; thus solving a very important section of one of the most important of all geographical problems, and obtaining for England and the nineteenth century a reputation for discovery that the wisest of the ancient Egyptians and their conquerors from the earliest days of civilization have failed to secure.

Since those few lines were written Captain Speke and his fellow-traveller, Captain Grant, have returned to England, and have communicated some of the main results of their long, arduous, and dangerous expedition. Before giving an outline of these, let us briefly review the previous state of the problem and the extent of the work really done. Besides being of the highest interest as a question of descriptive geography, the results of exploration in north-eastern Africa, as commenced by Captain Burton and Captain Speke, and now continued and nearly completed by the latter, are of the most extraordinary interest, and help us to understand the physical geography and resources of a large section of the African continent. The key to the explanation of all that is peculiar to Africa has been now obtained by the combined labours of Livingstone, Burton, Speke, Grant, and Petherick.

It was towards the end of June, 1857, that Captain Burton and several companions left the African coast near Zanzibar, on their way into the interior, determined to attempt the discovery of the sources of the White Nile from the east and south, instead of repeating the attempts that had been so frequently and unsuccessfully made to trace the river by following it up stream.

From the time of Herodotus downwards there had been vain attempts made by European explorers to discover where the waters of the great river originated, and what was the cause of that mysterious rise by which Egypt was flooded and fertilized. No doubt the traders from Arabia have crossed all parts of northern Africa from the east to the centre, and they may even have reached the west coast, but no information could be obtained from them but the vaguest reports. Accepting these implicitly, and interpreting them naturally and without theory, there had been maps prepared during and since the middle ages, which are really as correct as any maps

could be without accurate observations. In other words, they express vaguely the fact that the country is covered with numerous lakes near the equator, and they do not allude to mountains. But this was opposed to all prevalent notions, and, as in other more familiar districts, great rivers originated in lofty mountains, so in Africa, where the ancient geographers had spoken of "Mountains of the Moon," it was concluded that there must be a lofty central chain, and all the ideas of the Nile were modified by this assumption.

In the year 1768 Bruce proceeded to Egypt to trace the Nile from its outlet to its source. It was then known that at a certain part of its course there were two great feeders of the river, one of which was called the Blue Nile, and this was known to proceed from the Abyssinian mountains. The other, the White Nile, was believed to be comparatively unimportant, chiefly from the theoretical reasons alluded to, though partly because its importance really seems to be masked near the junction. When, therefore, Bruce in Abyssinia visited the head waters of the Blue Nile, he thought he had solved the problem of antiquity.

It was soon found out, however, that the White Nile must also be followed, and its history ascertained. Recognized at an early period as an important branch, it ultimately became evident that it was the real river, and, although obstacles to its navigation existed, and there were great difficulties in exploring it, owing to the numerous savage tribes in that part of Africa, it was a geographical necessity that the source of the river must be sought for much nearer the equator than Bruce had imagined. Exploring parties were organized, and great efforts made by the Egyptian government between the years 1835 and 1841, the result being a doubtful and greatly questioned discovery, which may be considered, however confirmed, at least in its chief points, by Captain Speke, that in latitude 3° 40′ north, and at a distance of more than 3000 miles from Alexandria, the river was still a wide stream, broken by a series of cataracts, coming from a distance described as thirty days' journey in the interior. The longitude, however, of this furthest point of the expedition was not clearly determined, and it may still be that some feeders coming in from the west may help to drain the interior of the continent halfway between its eastern and western shores.

Among the discoveries of other explorers, partly confirmed by the subsequent researches, but still in some measure doubtful, owing to the want of accurate observations of latitude and longitude, may be mentioned the statement published by Mr. Petherick, British Consul at Khartoum, who, in several trading expeditions, and with much personal risk and trouble,

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advanced almost to the equator from the Bahr-el-Ghazal, a remarkable lake or expanded arm of the Nile. Mr. Petherick describes a country without great undulations of the surface, traversed by a westernmost branch of the Nile, which he believes to meet the White Nile in this expanded swamp.

When, then, in 1857, Captain Burton and his enterprising companion, starting from the east coast at Zanzibar, between 6° and 7° south of the equator, decided to go so far into the interior of Africa towards the west as to cross the direction of any north and south water-course, or mountain chain, and lay bare the geography of that part of the continent, they really had to make discoveries at every step. There was a certain idea, prevalent already in the minds of geographers, that the east as well as the west coast of Africa contained much elevated land, but that there were no great mountain chains in the far interior. The lofty mountain chain reaching southwards from Abyssinia, broken, perhaps, here and there, but culminating in the snow-covered peaks of Kilmanjoro, descends to form a range of mountains from 6000 to 8000 feet in height, connected with a plateau of inferior but considerable elevation, commencing about 150 miles from the coast, and of great width. Beyond this and further to the west the ground descends considerably, and there is no evidence of any mountain chain in this direction. Within the plateau, which is here 120 miles wide and 4000 feet above the sea, is the large and remarkable lake visited by Captain Speke in 1858, and described as the Victoria Nyanza. Beyond it to the west is another great lake (Tanganyika) at a very much lower level, connected apparently with other lakes to the south, and having no communication with Nyanza.

After Captain Speke had reached this lake in 1858, and had compared notes with Captain Burton, who had by that time visited and explored the more westerly lake of Tanganyika, he was convinced that by continuing northwards from the southern shore of the higher lake, he should find that its waters communicated with the Nile. Unable then to decide the point, he was obliged to return to England; but shortly afterwards, expeditions were organized on the one hand to enable Captain Speke to continue his investigation as suggested, and on the other to secure assistance, should he be able to cross the equator, and fall in, as was most likely, with troublesome native tribes inhabiting the country already partly described by Mr. Petherick. It was not till the end of 1861 that Captain Speke, accompanied by Captain Grant and a long train of native attendants, reached once more the southern extremity of the lake, on whose exploration so much depended. He then passed round the lake to the west, and found there a network of ponds and lakes, all

receiving streams from the south, and pouring them into the Victoria by a channel, which also in its course receives the drainage of several other lakes. The river thus fed is a considerable stream before emptying itself into the Victoria. It runs through a deep ravine, eighty yards wide, and flows at the rate of five miles an hour. The sources of these feeders are said to be in an extensive tract of mountain-land, situated north of the great lake of Tanganyika, described by Captain Burton, and receiving very large supplies of rain, which may probably be periodical. These mountains do not seem to have been visited.

Should this view be correct, it would seem that the main chain crossed in travelling from the coast turns round, and extends westward, representing, in fact, the chain, though probably of no great elevation, so often described as the "Mountains of the Moon." Captain Speke reports that in the year 1862 there were 238 days in this district on which rain fell, and the high lands would seem to supply at all seasons a very large body of water to the elevated lakes terminating in the Victoria Nyanza. The eastern side of the lake is said to consist of low hills intersected with deep ravines, and a large island is spoken of by the native traders as existing in another and smaller lake in this direction, from which salt is procured. The waters of all the lakes are sweet.

From the great lake thus fed by numerous streams, entering by innumerable channels, the White Nile issues. It proceeds from a point situated midway along the northern shore. The stream, as it emerges from the lake and enters on its course, first leaps over a vast heap of plutonic rocks, falling about twelve feet into the plains below. From this point, called by Captain Speke the Ripon Falls, the Nile has cut a channel through sandstone hills for some distance, and continues to run towards the north with great impetuosity. It loses itself for a time in marshes of vast extent, which present the appearance of a lake (like the Bahr-el-Ghazal, and other swamps much further to the north), receiving at various points tributary streams of considerable magnitude. It remains, however, a navigable stream for some distance, until it again falls in a large cataract into a district sloping rapidly to the west, where the river once more flows with great rapidity. Here, however, Captain Speke and his companions were compelled to leave it, owing to the troublesome character of the people on the banks. After joining it again at Madi, the travellers found the course to continue as before, receiving the important branch called the Asoua on the right bank, and the Bahr-el-Ghazal, at some distance beyond, on the left. The latter is a very large branch, and may perhaps be a more important affluent than is supposed.

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It is at any rate so far important that its junction with the White Nile is marked by very extensive and almost untraversable swamps. As an incoming affluent, it appeared to be almost without current, but this might be owing partly to the greater impetuosity of the main stream checking its course, throwing its waters back, and producing the large expanse of swamp. Several tributaries of various magnitude enter the White Nile from the east or right bank, but these are connected with the drainage of the mountains in that direction.

It is quite evident from this account, *First*, that the principal tributaries of the White Nile come in from the high lands surrounding the Lake Victoria Nyanza, near the equator. *Secondly*, that the mountain chain to the east includes the lofty snow-covered mountains, probably volcanic, described by the German missionaries, and probably continued as a coast range, passing to the south and east of Nyanza. *Thirdly*, that the main sources of water supply are not far from these high mountains, but proceed from lower intertropical and sub-equatorial ranges separating the plateau from the lake system of Tanganyika, described by Captain Burton. All the chief swamps, the deltas, and the complicated channels are spoken of by Captain Speke as coming in from the west and south, while only three or four complete rivers enter from the east; and, moreover, both the main river entering the lake, and the stream emerging from it towards the north, appear to be very much larger and more rapid than any other tributaries. *Fourthly*, that there is a certain obscurity still left as to the river (not the swamp) called Bahr-el-Ghazal, both as to direction and importance, for it is possible, though perhaps not very likely, that this stream comes in from the far west. *Fifthly*, that the old question of the existence of a chain of mountains crossing the African continent is almost revived by this recent discovery of Captain Speke, although it had been more than questioned by most modern geographers. It is still possible that the great abundance of running water feeding the lakes may come from such mountains, and may be the result of a long line of slopes stretching away into the interior of the continent. But though possible, all analogy and probability are opposed to this assumption; and it is much more likely that the apparent chain is a termination northwards of the plateau which dies away in the great Sahara.

The native tribes met with by Captain Speke, on the north side of the lake, seem to be connected with Ethiopia ethnologically, but offer many points of great interest. They are even regarded as descendants of the ancient Ethiopians, and they retain a curious tradition of their ancestors being half black, half white, and having half their hair crisp and woolly, and the other half straight and lank. There is no doubt that this rela-

tion rather tends to indicate a natural hill-boundary between the tribes to the north and those to the south of the equator. Captain Speke reports that, in this strange government, uncleanliness and ingratitude are regarded as capital crimes; that a female guard surround the king; that this potentate must not be approached in any other than the most lowly attitude, and that not even the presents made to him must be exposed to vulgar gaze.

Since Captain Speke's return, a French traveller, M. Miani, writing from Venice, has endeavoured to throw doubt on the importance of these results, by a statement to the effect that the principal branch of the White Nile is one of the streams that proceed from the mountains to the east. That the extremely lofty mountain chain, occupying this position, supplies very large feeders, is by no means unlikely, and that during certain seasons, when the summer sun dries up many streams, it may, by melting the snow on the steep sides of Kilmanjoro, largely increase some other sources of supply is not improbable, but the general result of Captain Speke's investigations seems based on observations too accurate to permit of this error. The results of M. Miani's visit to the other sources cannot fail to be full of interest, especially if they introduce us to the upper valleys of the snowy range, of which we at present only know that it exists.

Many are the expeditions that have been made from the Upper Nile in search of adventure and discovery in this remarkable and mysterious river. Mr. Petherick, already alluded to, believes that he reached the equator at a point distant only sixty miles from that known to be crossed by the Nyanza, a fact of great importance if true, but which requires confirmation, owing to his not having had instruments to determine his position with accuracy. The Egyptian expedition was, in like manner, and for similar reasons, untrustworthy. In the early part of this year a very remarkable enterprise was undertaken by three Dutch ladies, Madame Tinne, her sister, and daughter, who embarked at Khartoum on a small steamer, accompanied by four other ships, carrying in all as many as 200 persons, and proceeded up the Nile with a view to trace the westernmost affluents. Among the companions of these ladies were two travellers, M. de Heuglin and M. Steudner. The ladies had previously visited Gondokoro (within $4\frac{1}{2}$ degrees of the equator), and had made excursions from thence. They have now passed the Bahr-el-Ghazal, and having entered the river of that name, are endeavouring to advance into the interior. As far as the sheet of water called Lake Rek, about 600 miles south-west of Khartoum, the country is known, but all beyond is still mystery. The remarkable tribes of the Niam-niams, who inhabit this part

of the continent, are said to form three tribes—one of them inhabiting a mountainous and wooded country, and working iron and copper, whose ores are found in the soil. Some people of another of the tribes are said to have rudiments of a tail, and the third are said to be of comparatively white colour, and, although living almost under the equator, far more intelligent and active than is usual among native Africans. M. de Heuglin, travelling as we have said with the ladies Tinne, believes that these reports are not without foundation.

Although, then, one more of the main sources of the Nile is certainly discovered, and this gigantic river has now been followed in a north and south line from the Mediterranean to the equator, although the Blue and the White branches are traced to their hiding-places, and the sources of many of the other tributaries must be regarded as settled, yet, in spite of all this, there are still unexplained mysteries, and sufficient left for future travellers to see and describe.

The problem of the interior of Africa still, therefore, remains to be solved as regards some sufficiently important details, but it is gratifying to know that a few of these are in the way of being settled shortly.

The great water system of Africa is now much better understood than it was a few years ago, and the mystery that connected itself with African geography is being rapidly dispelled. Dr. Livingstone has crossed the continent, and by following the course of the Zambesi and some of its tributaries, he has prepared us to understand a system of drainage quite different from that of Europe, Asia, and America. Much that is most remarkable both of vegetable and animal life in Africa, not only with regard to the lower animals, but man, must be referred, and can be explained by a reference to this condition. There is now no need to assume high mountains in the interior, for Africa is a basin, vast, no doubt, in extent, but simple in its plan, and the river systems are all derived from the broad elevated rim of this basin. Within this rim, four or five hundred miles wide, and varying in height from four to ten thousand feet, though not without lofty exceptional peaks, there is enclosed a space—the whole of Central Africa south of the equator—within which are formed, and through which run large streams, only able to escape at one or two points where the rim is broken. Whether the Nile communicates with this network of the interior has lately been a question. On the one hand, there were the great lakes, probably, as it seemed, connected throughout the east coast, and the apparent absence of any extreme difference of level between these and the northern river. On the other hand, was the mysterious flooding of the Nile, the constant outpouring of its waters towards the north, and the ab-

sence of any rational explanation of many well-known phenomena. All Africa contains but a few rivers of importance, and of these, not one besides the Nile is a first class stream as it enters the sea. The Niger is choked, the Zambesi is choked, and the Zaire is hardly visible. None assume the character of a wide rapid river, pouring an incessant stream, unbroken and unchanged by events going on in the interior of the continent, and hardly one is continuously navigable.

We are now beginning to see in what the Nile resembles, and in what important points it differs from the other principal rivers of the world and the streams of Africa. Unlike other rivers, for the last thousand miles of its course it receives no tributary. Exposed to the drying winds that have crossed the desert either of Africa or Arabia, it yet preserves its water supply with unvarying regularity, and when the usual season comes it rises rapidly, and overflows a large tract of low flat land. It bears down from the interior of the country a vast amount of mud to fertilize these plains. Silent and inaccessible, for ages the sources of this stream have been looked for, and some mountain system worthy of so gigantic a result has been from the earliest times hypothetically named and described. It is hardly too much to say that no such system exists. Mysteriously generated under the burning and vertical sun of Central Africa, fed by a network of streams draining an extensive, richly wooded, and not lofty table land; here and there expanding into swamps crowded with the hippopotamus; at intervals rushing along through ravines, or falling over rocks and ledges; always large, always full, always important, this river, a giant from its birth, is the outlet of a group of lakes, and is thus connected with the peculiar drainage system of its continent. As it emerges into the lower land towards the north it is also flanked by the loftiest mountains of the continent, with their summit peaks covered with perpetual snow, and receives from them a supply which never fails, and which is greatest in the greatest heats of the tropical summer. But the tropics have no winter; they may, indeed, be drier at one season than another, but the abundant vegetation observed is the proof and the result of rarely ceasing rain. Thus the Nile combines the sources of supply elsewhere distinct. It is fed by the perpetual tropical rains, but it is fed also by the perpetual melting of mountain snow. It receives perpetual contributions from the south and west, and perennial tribute from the east; and this rush of water, increased at certain seasons, is, as it were, kept up from point to point along its course in the great swampy flats, as well as in the numerous lakes. As other streams originate in springs or glaciers—as some rush forth from the earth ready formed—so the Nile originates in lakes

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and swamps, from which it emerges wide, rapid, deep, and navigable. For hundreds of miles all the additions it receives, and they are many and important, seem to do no more than keep it as it was. It remains large and full, but nowhere increases greatly in width, or rapidity of course or depth. After the largest affluents have combined their waters with the main stream there is still little difference. After the longest and most exhausting seasons of drought and incessant evaporation from a large surface in a burning climate, the Nile is still full, and often then begins its mysterious and periodic rise. This great mystery of geography, this miracle of Egypt from the earliest occupation of the country to this day, is thus seen to be the result of many circumstances, combining to ensure not only a perpetual water supply, but the required periodical flood at the exact season when it is most useful and least to be expected.

The general outline of the present great discovery of Captain Speke was certainly more than suggested, both by ancient and modern geographers—among the former by Ptolemy, and among the latter by Dr. Beke. So long ago as in 1846, the latter traveller, in a memoir read before the meeting of the British Association for that year, "inferred that the head of the Nile is most probably situated in about 2° S. lat. and 34° E. long., at the extreme eastern edge of the table land of Eastern Africa, and at a distance of 300 or 400 miles from the island of Zanzibar." This is the actual position of the Lake Victoria Nyanza. At the same time Dr. Beke suggested that "there is a third great arm of the Nile, namely, the Bahr-el-Ghazal, which joins the central from the west." The extreme probability of this, and the fact that this arm still remains to be explored, add interest to this opinion, expressed long before the commencement of those expeditions that have had so glorious a result.

It must not be forgotten, in concluding this notice, that the much disputed question of the existence of a group of mountains, called the Mountains of the Moon, again comes before us. Ptolemy, and since his time a multitude of geographers, have placed this supposed range in an east and west direction across Africa, to cross the direction of the Nile at right angles. Instead of this the chain, if it exists, is in a very different direction, is much shorter than had been supposed, and is probably much loftier. There are, however, two mountain chains that might be so called—one is the extremely lofty and snow-covered group, of which Kilmanjoro is the culminating summit; the other is the local range recently described by Captain Speke as occurring to the north of Tanganyika. Though much less lofty than the other moun-

tains, these latter are more nearly identical in position with the range formerly described. The question is, however, chiefly one of name, for there is little doubt that the really lofty mountains are grouped near Kilmanjoro, and are not far from the coast; while the high ground north of Tanganyika, though a water-shed, is by no means important in any other sense. That the existence of a chain separating the basin of the Nyanza from the basin of the Nile is absolutely disproved by Captain Speke, is a result of extreme interest, and also settles points that had been long disputed. It still remains to decide whether, according to Captain Burton, "an elevated mass of granite and sandstone crosses from the shores of the Indian Ocean to the centre of tropical Africa;" for this is of course possible, although it does not, as Captain Burton supposed, exclude Nyanza from the drainage basin of the Nile.

We now await the last stage in the discovery of the sources of the Nile. It is still possible that, far away towards the centre of the continent, there are waters that run eastwards to supply the great river, but it is certain that so far as the east and south are concerned the limits are determined. Whether Consul Petherick's party, or Madame Tinne and her suite, will be the next to give us information it is not easy to say. Both parties are busily engaged in the same work, and the result, whatever it may be, will be looked for with extreme interest by the civilized world. Meanwhile Captain Speke has worthily and well carried out and completed the task he had so boldly set himself.

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CLUSTERS OF STARS AND NEBULÆ.—THE SURFACE OF THE MOON.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

Our recent survey, in these pages, of the more conspicuous and interesting of the double and binary stars will, it may be hoped, have led the astronomical inquirer to wish for a still more extended knowledge of that glorious host of suns which surrounds him in every direction. It will be our object to give him such further assistance as we can in this noble pursuit, and therefore, quitting for the present the branch of study which has hitherto occupied us, we will choose a fresh point of view, and proceed to the consideration of other and more complicated arrangements.

It is impossible to look upon the open heavens without an instinctive conviction of the unequal distribution of the stars in space; some regions are left comparatively vacant; in others, there is a crowding together of stars so nearly corresponding in magnitude as to leave no doubt as to their actual combination in groups; the individuals of which may possibly be separated by distances baffling all human conception, but which yet show mutual connection as compared with the void space surrounding them. Of course a similar appearance would be the result, if they had only an optical and not a real proximity, being merely arranged nearly in the same direction with regard to our sight. But in order to produce this effect, there would necessarily be so strange a counterbalancing of distance and brightness, that we perceive at once the improbability of such an explanation. There are, no doubt, occasional instances of apparent equality resulting from such compensations of remoteness by superior brilliancy, because amid the profusion of the heavens there is room for every alternative; and, as it has been truly observed, an event, against the probability of which there are 10,000 chances to one, will yet actually occur, if it has 10,000 chances given to it. But still we shall be quite safe in concluding that such instances of apparent proximity are not the rule but the exception, and that in the case of large aggregations such an exception will approach impossibility. It may be very possible with regard to any two equal and adjacent stars, that their apparent neighbourhood may be a deception, from the compensation of brightness by distance; but the probability of such an arrangement will be much less where three are concerned, and will very rapidly diminish with increasing numbers. The evidence of sense is fully in accordance with this unquestionable deduction. We cannot look upon the three well-known stars in the belt of Orion without a dis-

tinct impression that they are all nearly at an equal distance from us; the same is the case with the seven of the Great Bear, and especially with the little constellation Delphinus, easily recognized during the evenings of the present season at some height in the southern sky, to the left of the brilliant Al Tair. No principle of perspective could be reasonably called in to account for the aggregation of so many stars of nearly similar magnitude within so small an area. Other instances might be given of groups, as such associations of stars may be properly called, visible to the naked eye; but it is in the expanded range of the telescope that they become more universally apparent. There we shall frequently meet with fields characterized by the prevalence of stars of a certain size, and where the evidence of actual vicinity, and oftentimes of very remarkable arrangement, is too obvious to be overlooked. These "groups," however,—adopting the accurate classification of Sir W. Herschel, who thus designates compressed collections of stars without central condensation, but forming insulated systems,—present only the simplest form of combination. In the continuance of our researches, and especially if we progressively increase the light of our telescopes, so as to penetrate further into the depth of the heavens, we shall discover a regular series of these aggregations. Groups will come into view not only more rich in numbers, but more thronged by the real or apparent nearness of their individual components; we shall not only notice a tendency to condensation towards the centre of the mass, which may be, though to a very limited extent, the effect of perspective from the greater length of the central visual line, but we shall find, in many instances, a degree of internal compression which perspective is inadequate to explain; and thus we shall be obliged to infer a degree of mutual proximity in that region which we have no means of estimating, but which, upon any supposition, must lead to thoughts of wonder as to the general structure of the mass. Such an assemblage, if its general outline were circular, as is frequently the case, would no longer be denominated a "group," but a "globular cluster," "clusters" being, according to Sir W. Herschel's definition, groups so arranged as to indicate the existence of a central force. To many of these most interesting objects we hope to direct our readers.

But we shall soon find that we are, practically at least, dealing with infinitude. Some of these clusters will exhibit their component stars with little difficulty in an ordinary telescope; in others, from the minuteness or the compression of their members—a natural result in either case of increased distance—we shall obtain a less perfect picture, and the general mass will assume a hazy aspect, though its real character will

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be fully indicated by the sparkling points of light which mark the places of the brighter individuals, or, perhaps, the spots where two or three fall into the same line of sight. Such an object would be called an "imperfectly resolved nebula," a Latin word signifying fog, and well expressing the distinctive aspect of these bodies. Others, refusing to give up separately their component stars, present a mottled or granulated appearance, which the experienced observer well understands, and which enables him to class them as "resolvable nebulæ," that is, nebulæ which would, under other circumstances of distance or optical power, be resolved into stars. While lastly there are those, whose light is so *milky*, to use an epithet introduced by the elder Herschel, so uniform in its diffusion, as to mask completely their starry nature, and to render them "irresolvable." This remarkable and instructive progression cannot be adequately exemplified to the naked eye, because it so happens that we have no good specimen of a globular cluster sufficiently near to us to form the first step in the scale by its sensible resolution; but every telescope of sufficient power to resolve fairly the nearer clusters exhibits a series of this kind, passing from the group or cluster, which is a fully resolved nebula, to the irresolvable nebulosity which from analogy is, or may be, a group or cluster at an unapproachable distance; and each telescope has a series of its own, corresponding with its optical capacity; every increase of aperture, by its greater resolving power, increasing the number of groups and clusters at the expense of nebulæ, and yet so adding to the ranks of the latter by the addition of still fainter and more evanescent objects, that the sum total still goes on progressing, as though it were actually illimitable. Many an aggregation which appears but as a dim and hazy speck in our smaller telescopes, is wholly disentangled into separate stars by the reflectors of the Earl of Rosse, or Lassell, or Chacornac, or by achromatics such as those of Clark, or Bond, or Struve, or Secchi; while these again convert the "milky" into the "resolvable" nebulæ, and draw out of the unknown depths of space yet further, and obscurer, and previously imperceptible evidences of the incomprehensible magnitude of this great and wonderful universe.

Such is a broad and simple view of this grand subject. Whether this apparent simplicity is founded in the truth of nature, or whether it may prove one of those premature generalizations which only obstruct the path while they seem to clear it, need not be discussed at the present time, though it will ultimately come before us. But it is desirable, before proceeding further, to obviate any misconception which might arise from this mode of statement. We must bear in mind that our two assumptions, of sphericity of form in the mass, and

similarity of magnitude in the individuals, are only partially applicable. The forms of clusters and nebulæ are indefinitely varied; many being elliptical, a few spiral, others perforated, others again extended in length, branching, or contorted in various figures, while their components are by no means always all equally bright, the reverse frequently opposing a difficulty in the way of complete resolution, when the telescope can master the more resolvable portion, but leaves the smaller individuals merged in a general haze. In another respect, too, our statement requires qualification. It has been asserted that the apparent minuteness of the individual stars in certain clusters, as compared with others, may be the result of increased distance from the spectator, and the series which we have imagined is based upon this idea. It was that of Sir W. Herschel, who thus assigned the probable distances of nebulæ, in progressive remoteness, till they passed even beyond the space-penetrating power of his forty-feet reflector, which he estimated one hundred and ninety-two times greater than that of the eye —a value corresponding to three hundred thousand times the distance of Sirius! But this magnificent conception has been entirely overthrown by more recent discoveries. It rested upon the assumption that the distances of the stars are, on an average, in the inverse ratio of their apparent magnitudes—an assumption not merely recommended by its simplicity and facility, but by its being probably the only one whose adoption could lead to any positive or numerical result. Of late years, however, its inadequacy has become more and more evident, upon grounds so lately stated in the present publication (Intellectual Observer, xviii. 454), that they need not be repeated here; and now it must be admitted that after so many years we find ourselves without a guide in the interminable wilderness of nebulæ. It is very possible that Sir W. Herschel's hypothesis may yet be correct as regards the majority of these objects, and it is unquestionably supported by the evidence of sense; but how deceptive this is has been demonstrated in the case of insulated stars and systems, and analogy has begun to lead us in an opposite direction. Analogy, with all its deficiencies, is like the one-eyed man, who has been said to be a king in the country of the blind; and reasoning from its indications where no others are attainable, we should have to conclude that the brightest and most resolvable clusters may be possibly as distant from us as some of those little heaps of "star-dust," whose aspect would bespeak for them a far more inconceivable remoteness, and that certain, again, of these latter may be even nearer to our system than some of those great and conspicuous stars, beyond which they were formerly placed at an immeasurable distance. In fact, whatever may appear pro-

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bable, nothing is, nothing can be, proved as to the relative position of nebulæ in space, without a determination of parallax, which the want of precision in their boundaries renders peculiarly difficult, if it should ever be possible.

Few of the nebulæ, or clusters, which an astronomer would designate by that title, are visible to the naked eye. The Coma Berenices and the Pleiades are undoubtedly groups which, removed to increasing distances, would gradually put on the appearance of telescopic clusters, resolvable, and at length milky nebulæ. Several other groups or clusters were classed by the ancients as "nebulous stars." Ptolemy, who wrote about A.D. 140, mentions five—the grand cluster in the hand of Perseus; Præsepe (see Double Star list, No. 5), "the manger," lying between two small stars, called in those days "Aselli," the little asses—incongruous appellations, the general acceptation of which it is not easy to understand; a group near Scorpio; another in the eye of Sagittarius; and one in the head of Orion (Double Star list, No. 99). But objects of this kind would give way at once upon the first application even of primitive telescopes, and thus Galileo readily perceived and delineated twenty-one stars in the head of Orion, and thirty-six in Præsepe. In addition to these, and two or three lying too far south to be visible in our latitudes, we may enumerate the great nebulæ in the sword of Orion, and in the girdle of Andromeda—neither of them, singularly enough, referred to by the ancients, or even by Galileo—a minute speck in Hercules, and another in Gemini, and we shall have pretty fairly exhausted the list as far as the unaided eye is concerned; though it is not improbable that, under very favourable circumstances, a few more of the larger clusters might be made out, as spots of evanescent faintness. The telescope, of course, would immediately enlarge the catalogue; yet this did not take place as rapidly as might have been expected. Halley picked up a few; La Caille added to the number; but the French observer, Messier, who was called the "Comet-ferret," from his unparalleled diligence in searching for those visitants, and was thus naturally led to notice every object of a similar appearance, formed a much more extensive list, comprising, with those already known, one hundred and three nebulæ. This was published in 1783, to be superseded, three years afterwards, by the labours of Sir W. Herschel. He had already attacked the subject in 1774, and the extraordinary and previously unattained "space-penetrating" power—to use his own word—of his great reflectors, together with the unwearied diligence with which he swept the heavens, enabled him to produce, in 1786, a catalogue of one thousand clusters and nebulæ; in 1789, a second quite as numerous; and in 1802, another comprising five hundred more.

The worthy inheritor of his name and talent observed, between 1825 and 1833, no less than two thousand five hundred, of which five hundred were discovered by himself; and his catalogue, published in the *Philosophical Transactions* for the latter year, is still the standard authority upon the general subject; the subsequent most memorable researches of the Earl of Rosse, with some important observations by Secchi and others, relating only to select objects. Very recently, however, the observatory of Copenhagen having been provided with a magnificent achromatic by Merz, of about eleven English inches aperture and sixteen feet focus, Professor D'Arrest, the director, commenced, in 1861, a general revision of all the nebulæ visible in that latitude—a noble enterprise, to which every lover of astronomy will cordially wish eminent success. The rank of his telescope he estimates exactly at a medium between Sir J. Herschel's of 18¼ inches, and Lassell's of 24 inches; it shows all the nebulæ of the former, and had even detected, during 8 months, 100, out of 776, decidedly unknown before. He finds that the nebulæ of the two Herschels, where their observations were sufficiently detailed and repeated, are nearly all unchanged; and he thinks we shall never discover more than a few variable nebulæ: the difference of brightness now discernible in a large proportion of Sir W. Herschel's objects being referred by him to an insensible alteration in the estimate formed by that great observer. The material upon his hands, he says, grows beyond all expectation; but the study is beset with much difficulty and uncertainty, and he thinks it not much more advanced, even now, than the knowledge of insulated stars was in the days of Tycho, or at the commencement of Flamsteed's labours. His observations on double nebulæ, including in that term those within a limit of 5′ of arc, are most interesting. He had, up to May, 1862, recorded 50, and thinks their whole number may be about 300 among the 3000 of the general list. Their physical connection as binary systems, already suggested by Sir J. Herschel, he considers unquestionable: the mere aspect proves it abundantly, especially when some unusual form characterizes each object; and in future times the computation of the orbits of such systems will doubtless become matter of inquiry. He points out, but as a mere indication, a double nebula, whose distance was given by Sir W. Herschel in 1785 = 60″; by his son in 1827 = 45″, with a position-angle = 45°; and by D'Arrest in 1862 = 28″ and 56° 32′. Like all other observers, except those at Poulkowa, he testifies to the entire disappearance of Hind's wonderful nebula in Taurus (see INTELLECTUAL OBSERVER, iii. 244); but he considers doubtful a similar occurrence stated by Sir J. Herschel to have taken place in Coma Berenices, on account of the great

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difficulty in identifying Herschel I.'s nebulæ in this region. He questions also the variation of another nebula mentioned by Schmidt. Three, however, of Sir W. Herschel's nebulæ—two of them of his first or brighter class, the other of his second—he has failed to find. The proper motion, which has been suspected by some astronomers in nebulæ, he thinks improbable. From time to time we hope to be favoured with further accounts of his progress in his most difficult, but most valuable and interesting, undertaking.

No objects (if we except comets, to which they often bear a curious resemblance) are more benefited than nebulæ by an increase of optical light. This is a natural result of the faintness and haziness which is their usual characteristic; and for their mere discovery or recognition, defining power is of less importance than breadth of aperture. When, however, the attempt is made to detect their starry composition, accurate definition resumes its usual supremacy; and increase of power is here important, as tending, by separating the minute points of light, to draw them out of the general haze. At the same time the want of contrast with the open sky attendant upon the contracted field of a high power is a serious disadvantage, and deep magnifiers should only be employed after the eye has become familiar with the object in the use of low and progressively increasing powers. The brighter nebulæ may be seen with so small an instrument that it seems singular that so few of them were noticed before the time of Messier. They are often perceptible enough in the fields of our finders. With an object glass of only $1\frac{1}{4}$ inch, in youthful days, I made out, undoubtingly, though of course dimly, several of these objects, and could have seen more had I known where to look for them. An object glass of $3\frac{7}{10}$ inches showed a great number very satisfactorily; and with $5\frac{1}{2}$ inches the brighter clusters are beautifully developed. They require, of course, from the minuteness of their components, a darker sky than the majority of the double stars included in our list, and in haze, twilight, or moonlight, the search would be to little purpose. A popular catalogue of the more remarkable of these interesting objects will shortly follow.

THE SURFACE OF THE MOON.

In reverting to this subject, which has now, from the pressure of other interesting matter, been intermitted for a considerable time, we would point out to the inexperienced observer that, although, in mastering the difficulties which have been already indicated as existing in the accurate study and delineation of the surface of the moon, he will have advanced very far towards the attainment of his object, there still remains a source of perplexity, which will not indeed cause

him much embarrassment if he merely wishes, as is usually the case, to obtain a good knowledge or satisfactory drawings of lunar outline or relief, but which ought, nevertheless, to be clearly understood and taken into account. It would form of itself a most interesting investigation, and one as to which, at present, not much seems to have been done; and it is to be hoped that it may be taken up as a distinct but very important branch of selenography by some out of the many amateurs who are now directing telescopes of abundant competency towards our satellite. We are referring to the very remarkable effect of the different reflective power of different portions of the lunar surface. This, of course, is perfectly developed in the full moon, when, from the coincidence of the direction of vision with that of illumination, all true shadows disappear, and the circular disc, if homogeneous in its nature, would be overspread with an unvaried brightness, instead of that strange intermingling of clouds and stains and streaks and patches of light and darkness which is visible in some measure to the naked eye, and is so peculiarly unintelligible in the fuller revelation of the telescope.

There can be no doubt that the cause of all this variety is to be sought in the local colour of the surface, whose tints, however diversified, would naturally, at that distance, be so blended and confused as to assume the appearance of different shades of grey; but it is not so easy to comprehend the singular manner of their disposition, and it would be a curious inquiry how far any terrestrial analogy would help us towards an explanation. It is probable that, in some respects, our own lands, if viewed from the moon, would present an aspect not very dissimilar. The variegated hues of our familiar landscapes, the red tint of many soils under the plough, the green of our meadows and woods, and the yellow of our ripe corn, would not be separately recognized from their small angular extent, but would produce by their intermixture a neutral tint of varying degrees of intensity in different places; and if it should be objected that where the masses of colour are sufficiently extensive their separate existence ought to be recognized, and that we cannot suppose any difference beyond that of brightness between the aspect of the sands of Sahara and the forests of Brazil, it may be replied that some such indications of widely-spread local hues have actually been traced in the moon by Beer and Mädler, and that Piazzi Smyth was obliged to have recourse to colour to give sufficient likeness to his spirited sketches, at first attempted in one uniform tint. But this would still leave unexplained much that the student will soon find to be very strange in the disposition of the lunar lights and shades, and especially in connection with the forms

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which they overspread and frequently obliterate. Some general rules may be traced, but exceptions are numerous and unaccountable; and while on the earth a similarity of structure and composition in neighbouring objects would be in all probability attended with similarity of colour, this is so far from being universally true in the full moon, that it is no uncommon thing to see one of two adjacent and resembling craters or ridges conspicuous at that time for its brightness, while the other shows scarcely a trace of its existence. This interesting subject will come before us again in detail; it is only adverted to in this place as occasioning some preliminary obstacles to the student in regard to the identification of many of the lunar spots, which from this cause becomes perplexing and uncertain, in proportion as the relief of the surface gradually disappears with the increasing angle of illumination.

Difficulties, if such there be, arising from the supposed varying conditions of the lunar atmosphere, will present themselves as matters of local inquiry.

In addition to the statement respecting the apparent dichotomy of Venus in p. 455 of the last number of the INTELLECTUAL OBSERVER, it may be remarked that the same phenomenon of disagreement with calculation was observed by De-Vico and his associates at Rome in 1839, the terminator becoming sensibly straight three days after the time specified in the tables.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*June* 17.

On the Tertiary Shells and Corals of Jamaica.—Mr. J. Carrick Moore communicated the result of an examination of 71 species of Tertiary Mollusca from Jamaica, mostly collected by the late Mr. Barrett, showing that 12 are still living, and that 28 are common to the Tertiary beds of Jamaica and St. Domingo. The same relation between those deposits had been found to exist by Dr. Duncan through a comparison of the Corals. The "Pacific" affinity of many of these Shells and Corals was noticed as confirmatory of a conclusion arrived at by the author in a former paper; and it was shown, from the occurrence of Tertiary beds on the Panama Isthmus at a height of 250 feet above the sea, that the complete separation of the Atlantic and Pacific Oceans did not take place until after the commencement of the Tertiary period.

LINNÆAN SOCIETY.—*June* 18.

Cinchona Bark from India.—The gradual, but certain destruction of the Cinchona forests of America, which has been viewed with so much anxiety by all who know how indispensable quinine is to the existence of Europeans in many of the tropical parts of the world, has lost its importance by the successful cultivation of the Cinchonas in India. At the meeting of the Linnæan Society, June 18, Mr. Howard exhibited the first specimens of Cinchona bark sent from India. It was stated that these had been found to yield a per centage of quinine, and the other febrifuge alkaloids, fully equal to that furnished by the bark of the same species when grown in South America. Mr. Howard also stated that quinine might be obtained in small quantities from the leaves. The successful culture of the Cinchona plants in India must be regarded as a subject of the highest importance, not merely to the prosperity of India, but indirectly to the whole world. The exploration and civilization of many tropical countries by Europeans being absolutely dependent on a supply of quinine.

CHEMICAL SOCIETY.—*June* 4.

Synthesis.—M. Marcellin Berthelot, of Paris, gave a lecture to the members of this society "On Synthetic Methods in Organic Chemistry." It was an able *résumé* of the chief steps by which complex organic substances have been built up from the elements carbon, hydrogen, oxygen, and nitrogen. Although no absolutely

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new facts were given, yet the treatment of the subject was such as to present some of the phenomena in a new light. It was illustrated by several experiments; the most interesting among these showed the first and most important synthetic step—the direct combination of carbon and hydrogen with formation of acetylene, $C_4 H_2$. The union was thus accomplished: A stream of hydrogen was conducted into a globe, in which the electric arc was shown between two carbon poles. The particles of carbon, transferred mechanically from one pole to the other, took no part in the chemical action, but the volatilized carbon combined, in the intense heat, with the hydrogen present. The acetylene thus produced was converted into a compound with copper; from this substance olefiant gas was prepared, and, finally, from olefiant gas, alcohol.

GEOGRAPHICAL SOCIETY.

On the Flora and Fauna of the Malay Archipelago.—Mr. Wallace's paper on the above subject was read by the secretary. The Malay Archipelago was stated to be an island region of continental dimensions and importance. Its varieties of surface, of geological structure, of climate, of animals and vegetables, and of races of mankind, are equally great with those of some of the primary divisions of the earth. The chief contrasts the islands present were then dwelt upon; volcanic and non-volcanic districts, forest regions and open plains, regular and irregular seasons, and, lastly, the Indo-Malayan and Austro-Malayan divisions. In treating of this last subject it was shown that the Archipelago was naturally divisible into two districts—the western, comprising the islands of Java, Sumatra, Borneo, and the Philippines, resembling the Asiatic continent in its animal productions; while the eastern, including all the other islands as far as New Guinea and the Solomon Islands, possessed all the chief geological characteristics of Australia. Corresponding to these divisions a physical peculiarity was shown to exist—namely, that the western islands were all united by a very shallow sea to South-Eastern Asia, while New Guinea was in like manner united to Australia. Asia and Australia were known to be more widely distinct in their animal and vegetable productions than any two portions of the earth; and it was shown that their peculiarities extended on each side into the adjacent islands, so that when you came to the little islands of Baly and Lombock, separated only by a strait fifteen miles wide, you had the productions of two continents brought into close contact without intermingling, the birds for example being almost totally different in the two islands, and not the species merely, but even the genera and families of the one not extending into the other.

NOTES AND MEMORANDA.

MR. GLAISHER'S ASCENTS.—The eleventh took place from Wolverton on June 26th at 1.3 p.m. The chief results are given in the following paragraph, written by himself. He says:—"This ascent must rank amongst the most extraordinary ever made. The results were most unexpected. We met with at least three distinct layers of cloud, on ascending, of different thicknesses, reaching up to four miles high, when here the atmosphere, instead of being light and clear as it has always been in preceding ascents, was thick and misty; but perhaps the most extraordinary and unexpected result in the month of June was meeting with snow and crystals of ice in the atmosphere at the height of three miles, and of nearly one mile in thickness."

The twelfth ascent took place on the 11th July. The balloon passed over Sussex and the currents of air were remarkable, the stratum moving from the N. being in contact with that from E. Mr. Glashier finds the velocity of air currents measured from balloon heights to be very much greater than what is shown by terrestrial instruments. He says, "The difference between the two is so large that it seems scarcely to be accounted for by the undulatory nature of the surface of the earth, and implies that our hitherto estimated velocities of wind are erroneous." Clouds were found four miles high, "when the temperature of the dew point must be some degrees below zero." This, with similar facts in a previous ascent, implies the presence of very little water; "yet," we are told, "there was enough in both cases not only to be very visible, but to exclude everything beyond them. This fact is important, and indicates that our theory of vapour must be reconsidered."

The thirteenth ascent was from the Crystal Palace on the 21st July, and afforded reason for believing that when rain falls from an overcast sky there is a second cloud stratum above.

AMŒBÆ, *princeps and villosa.*—Mr. H. J. Carter states in *Annals of Natural History* that he has often found villous appendages to the *A. princeps*, which confirms Dr. Wallich's opinion that *villosa* is not a distinct species, although it may be convenient to give it a separate name.

INSTINCT IN INFUSORIA.—Mr. Carter mentions in the paper from which the preceding remark is taken that he watched an Actinophorus Rhizopod extracting starch grains from a ruptured cell looking like a spore; the creature then retired some distance off, and then returned, and although no more starch grains were protruding, he contrived to extract some from the interior. "This," he says, "was repeated several times, showing that the Actinophys instinctively knew that these were nutritious grains, and that they were contained in this cell, and that although each time, after incepting a grain, it went away to some distance, it knew how to find its way back." He likewise mentions the cunning of an Amœba, which crawled up the stem of an acineta, and placed itself round the ovarian aperture, so as to receive an infant as soon as it was born. He observes that "these facts evince an amount of instinct and determination of purpose which could hardly have been anticipated in a being so low in the scale of organic development."

ABSENCE OF SUN SPOTS.—On the 5th July, the Photoheliograph at the Kew Observatory—which, it may be interesting to know, is worked by a very intelligent young woman, the daughter of an artizan—afforded a sun picture without a single spot. As we are now in the descending curve of the periodical variation in the quantity of these spots, and approaching the minimum, it will be important to learn how often they are totally absent. The Kew observations may be expected to throw much light upon the connection between these spots, and disturbances in terrestrial magnetism.

THE GASSIOT SPECTROSCOPE.—This splendid instrument, constructed by Mr. Browning, is now at the British Association Observatory, at Kew, in order to

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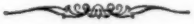
carry out the munificent intention of Mr. Gassiot, who gave the order for its construction, for the purpose of placing the finest possible means of spectroscope inquiry at the disposal of the cultivators of this branch of science. The instrument is furnished with nine exquisitely-finished prisms, possessing in the aggregate a very high dispersive power. The telescopes attached to it are two feet long, supplied with numerous eye-pieces and every appliance to facilitate delicate and difficult investigations. For any ordinary purpose, a less costly and complicated spectroscope is amply sufficient, and the famous researches of Kirchhoff and Bünsen were made with very inferior means. In able hands we cannot doubt that the Gassiot spectroscope will add an important chapter to the revelations of light, and it must be regarded as a noble instance of judicious generosity on the part of an esteemed and successful cultivator of physical science, and of exquisite skill as an optician on the part of Mr. Browning, to whom the credit of the construction is entirely due.

The Patent Achromatic Binocular Magnifier.—Having received from Messrs. Smith, Beck, and Beck a case of the instruments described under this lengthy title, and having employed them for many purposes, we can testify to their great superiority over the simple lenses they are intended to replace. They are composed of an achromatic combination on the binocular principle, but the lenses are so cut that the effect is like employing the centre only of an ordinary lens, and the angle is so arranged that the eye looks naturally through them, without any of the squinting or straining which makes ordinary magnifiers fatiguing and unsatisfactory. They are of three sizes, having focal lengths of seven, five, and three inches respectively, and can be used as hand magnifiers, attached to a neat handle, or mounted upon a novel and ingeniously-devised stand, which possesses a multiplicity of motions, and enables a very accurate adjustment to be made. We have tried them for viewing photographs, for microscopic dissection, and for looking into bottles and aquaria, and in each case have had reason to be satisfied with the facility and accuracy of their performance.

Structure of Blood Corpuscles.—Dr. William Roberts, of Manchester, has communicated to the Royal Society an account of experiments with human blood corpuscles, and those of other vertebrate animals. The reagents he employed were a solution of nitrate of rosanilin (magenta), prepared by making a nearly saturated solution by boiling the salt in water, filtering after twenty-four hours, and then slightly diluting it, and a solution of tannin, three grains to the ounce of water. A speck of human blood was mixed with a drop of the magenta solution on a glass slide; the corpuscles became transparent, and of a faint rose colour; they expanded sensibly, lost their bi-concave figure, and a dark red spot made its appearance on some portion of their periphery. When the blood of the oviparous vertebrates was employed, the central nucleus came fully into view, and assumed a deep blood-red colour; the oval form of the corpuscles was lost, and a dark-red spot appeared on their periphery. Tannin caused the corpuscles to bud or pullulate; one drop of blood mixed in a conical glass, with four or five of the solution, generally answered perfectly. The pullulations were easily seen under the microscope, by placing a drop of the tannin solution beneath the covering glass, and permitting a little blood to insinuate itself under it. The pullulations appeared organically connected with the corpuscles, but to form no part of their cavity. Dr. Roberts concludes from his researches that the mammalian corpuscles are homologous, as wholes, with those of the ovipara, and not with its nucleus, as supposed by Wharton Jones; and that the envelope of the blood disk is a duplicate membrane; in other words, that within the outer covering there exists an interior vesicle, which encloses the coloured contents, and in the ovipara the nucleus. He observes that Dr. Hensen, of Kiel, had attributed this structure to the blood corpuscles of the frog, and that in this view the blood corpuscle is anatomically analogous to a vegetable cell, and the inner vessel corresponds to the primodial utricle. Further details will be found in *Proceedings of the Royal Society*, No. 55.



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HORNED PHEASANTS.—MALES AND FEMALE.